Original Article

Success and survival rates of pit and fissure sealants performed by dental students and postgraduate students in pediatric dentistry

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Abstract

Objective: High-quality pit and fissure sealant (PFS) treatment can promote public oral health. The present study aimed to compare the success and survival rates of PFS treatments performed by dental students and postgraduate students in pediatric dentistry, and to evaluate the associated patient-related factors.

Methods: Patients who had received at least one PFS treatment performed by an undergraduate or postgraduate student during 2016-2018 were recalled. The age and gender of the patients, caries risk, oral hygiene status, DMFT, dmft, and the status of the PFS treatment in terms of retention rate and caries development were evaluated. The chi-square test, multiple logistic regression model, and Weibull accelerated failure time regression model were applied for statistical analysis.

Results: The success and survival rates of PFS treatments in the postgraduate group were significantly higher than those in the undergraduate group (P<0.05). Moderate caries risk and permanent tooth type were significantly associated with lower success rates of PFS therapy (P=0.02 and P=0.003, respectively). Additionally, increased dmft, moderate caries risk, and permanent tooth type were associated with shorter survival times (P<0.001, P=0.01, and P=0.009, respectively). High caries risk also decreased both success and survival rates of PFS treatment, but these alterations were not statistically significant (P=0.26, and P=0.55, respectively).

Conclusions: The success rate of PFS therapy is influenced by patient-, tooth-, and operator-related factors. PFS treatment is assumed to be more successful when performed by postgraduate students in the primary teeth of patients with low caries risk. (J Dent Mater Tech 2023;12(2):(73-81)

Keywords: Caries risk, Dental student, Pit and fissure sealant, Success rate, Survival rate

Introduction

Despite an overall reduction in the prevalence of caries in different communities, managing pit and fissure caries in posterior teeth remains a challenging issue due to the complex morphology of pits and fissures (1-4). Deep pits and fissures contribute to plaque retention, entrapment of bacteria, and inaccessibility for mechanical cleansing (5). Therefore, pit and fissure sealants (PFSs) were introduced to smooth out deep pits and fissures, preventing bacterial colonization and subsequent progression of caries by eliminating the nutrient supply of the bacteria (6-8).

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The use of pit and fissure sealants (PFSs) has become relatively common as a primary and secondary preventive strategy in public health practices (1, 5, 9-12). According to a Cochrane review, resin-based sealants can reduce the occurrence of pit and fissure caries in children by 11 to 51% over two years (13). A systematic review by Akinlotan et al. (14) indicated that PFS treatment is more cost-effective than other caries prevention methods. Furthermore, recent meta-analyses have shown equal effectiveness of PFSs and biannual fluoride therapy (15, 16).

Failure in pit and fissure sealant treatment is most often attributed to improper isolation or contamination with saliva or gingival crevicular fluid during the procedure (1, 17-19). Nilchian et al. (20) indicated that the effectiveness and longevity of PFS treatments do not significantly differ when administered by dental clinicians versus other dental healthcare professionals. It is worth mentioning that a majority of clinical trials have been conducted under ideal conditions by expert professionals. This approach often overlooks key patient-

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or tooth-related factors such as tooth development stage, child's compliance, and caries risk, all of which can markedly influence treatment success (1, 9, 21). For instance, the estimated annual failure rate of PFS treatment is reported to be between 5% and 10% (22). However, a study by Bakhtiar et al. (3) revealed that 53% of fissure sealant treatments performed in dental clinics that provide public health services demonstrated some type of failure. Furthermore, Memarpour et al. (23) documented a failure rate of 45.86% in school-based PFS treatments, as observed during an 18-month follow-up.

The treatment success of PFS can be influenced by the level of expertise and proficiency of dental students. Indeed, the inadequate experience of the operator, especially when treating pediatric patients, can affect the treatment result. This study aimed to compare the success rate of PFS treatments performed by dental students and postgraduate students in pediatric dentistry and assess the patient-related factors affecting the success and survival rates of the treatment.

Materials and Methods

This retrospective cohort study was performed using data extracted from the archives of the Pediatric Dentistry Department, School of Dentistry, Mashhad University of Medical Sciences, Mashhad, Iran. The present study was approved by the Ethics Committee of Mashhad University of Medical Sciences (IR.mums.sd.REC.1394.332).

Study design

The records of all patients treated by undergraduate or postgraduate students in the Pediatric Dentistry Department between January 2016 and October 2018 were reviewed. From this group, we identified those who had received at least one pit and fissure sealant (PFS) treatment on a primary or permanent tooth with no enamel or dentin deficiencies. These treatments were administered by either an undergraduate student in their fifth or sixth year of dental education or a postgraduate student specializing in pediatric dentistry. The exclusion criteria were applied when parents declined to give their consent for their child's participation in the study for any reason.

Primary or permanent teeth with deep pits and fissures requiring PFS therapy were treated by undergraduate or postgraduate students under the supervision of a pediatric dental staff. The treatment steps, according to the educational protocol of the Pediatric Department were as follows:

1. Local anesthesia administration (as needed)
2. Clamp and rubber dam placement
3. Cleansing the tooth
4. Etching with 37% phosphoric acid gel
5. Application of adhesive and light curing
6. Applying resin sealant and light curing
7. Rubber dam removal and occlusion check

Follow-up session

Patients were subsequently contacted by phone and asked to return for a follow-up. In the follow-up session, the objectives of the study were explained to patients and their parents or legal guardians, and they were requested to sign informed consent forms. The patient's demographic data including age and gender were recorded. The dental examination was performed by a postgraduate student specializing in pediatric dentistry under the supervision of a pediatric dental staff. The examination occurred on a dental chair under unit light, utilizing a dental mirror and explorer, as well as air/water spray. The assessment of restored and extracted primary and permanent teeth due to caries was performed based on dmft and DMFT. The oral hygiene status was scored using the simplified oral hygiene index (OHI-S), and caries risk according to the criteria set forth by the American Academy of Pediatric Dentistry (AAPD).

The quality of provided PFS treatment was then evaluated in terms of retention and categorized as full retention, partial loss, or total loss. Furthermore, caries status was scored as 0 to 3 based on the International Caries Detection and Assessment System (ICDASII) criteria (24). The presence of full retention and ICDASII-0 were considered treatment success, whereas other items were considered a treatment failure. The examiners and the data analyst were unaware of the group of patients' allocation. In case of requiring any further treatment, the patients were referred to the respective Department.

Data analysis

The collected data were analyzed in SPSS (version 20). The chi-square test was used to compare the success rate of PFS treatments performed by undergraduate students and postgraduate students in pediatric dentistry.

A multiple binary logistic regression model was applied to assess the correlation of independent variables (such as the age of the child at the time of treatment, gender, practitioner (undergraduate students or postgraduate students in pediatric dentistry), oral hygiene status, risk of caries, DMFT, dmft and type of tooth (primary or permanent) with the success rate of PFS treatment, which was considered the dependent variable.

The overall survival rate was determined using the Kaplan-Meier analysis. The survival analysis was performed based on the outcome of "survived" which was defined as a PFS treatment with full retention and ICDASII-0 at the follow-up session. The Weibull accelerated failure time regression model was also used via STATA 15 (StataCorp.). The dependent variable was "survived", whereas the independent variables were the age of the child at the time of treatment, gender, practitioner (undergraduate dental students and postgraduate students in pediatric dentistry), oral hygiene status, caries risk, DMFT, dmft and type of tooth (primary/permanent). A P-value <0.05 was considered statistically significant.

Results

Out of 2,400 archived records from 2016-2018, 530 met the inclusion criteria. From these, 227 patients (135 girls and 92 boys; mean age=95.51±22.83 months) attended the follow-up visit. These patients had 497 teeth that received PFS therapy (Figure 1). The average interval between the time of treatment and the follow-up examination was 1.8 ± 0.87 years. The mean OHI-S, dmft, and DMFT were 0.76 ± 0.51, 4.09 ± 3.37, and 1.40 ± 1.68, respectively. In terms of caries risk, according to the criteria set by the AAPD, 64.3% were classified as high-risk, and 18.5% were moderate-risk.

Partial loss was the most common cause of failure in both groups. This type of failure occurred in 23.8% (97 teeth) of undergraduate students and 16.9% (15 teeth) in the postgraduate group (Figure 2). The second most common cause of failure in the undergraduate group was total loss (Figure 2) with a frequency of 17.1% (70 teeth), whereas in the postgraduate group, the second cause of failure was the occurrence of secondary caries in the form of demineralization (ICDASII-1; Figure 3) with a frequency of 5.6% (5 teeth).

The results of the multiple regression test showed that PFS success in permanent teeth was significantly lower than that in primary teeth (odds ratio=0.27; 95% CI: 0.11-0.64; P=0.003). The treatment success in the postgraduate group was significantly higher than that in the undergraduate group (odds ratio=2.3; 95% CI: 1.12-4.71; P=0.02). The success rate of treatment was significantly lower in the moderate caries risk group compared to the group with a low risk for caries development (odd ratio=0.37, 95% CI: 0.16-0.86, P=0.02). The success rate of treatment was not significantly different between the high-risk caries group and the low-risk caries group (P=0.26). The age of the child at the time of treatment, gender, oral hygiene status, DMFT, and dmft showed no significant effect on treatment success (P>0.05).

Survival analysis

Based on the Kaplan-Meier analysis, the median survival duration for pit and fissure sealant (PFS) treatment was calculated to be 957 ± 20.14 days. The observed survival rates were 100%, 72%, and 32% at the end of the first, second, and third years, respectively (Figure 4).

The results from the Weibull accelerated failure time regression model showed that the survival rate of PFS therapy in moderate-risk individuals was significantly lower than in low-risk individuals (time ratio=0.90; 95% CI: 0.82-0.98; P=0.01), whereas the survival-rate of treatment in high-risk individuals was not significantly different from that of the low-risk individuals (time ratio=0.97; 95% CI: 0.90-1.05; P=0.55). Moreover, the survival rate of treatment in the postgraduate group was significantly higher than that in the undergraduate group (time ratio=1.09; 95% CI: 1.01-1.18; P=0.01). The survival rate of treatment in permanent teeth was significantly lower than that in primary teeth (time ratio=0.88; 95% CI: 0.81-0.97; P=0.009). With an increase in dmft, the survival rate of treatment significantly decreased (time ratio=0.97; 95% CI: 0.96-0.98; P<0.001). The age of the patient at the time of treatment, gender, OHI-S score, and DMFT did not exhibit a significant impact on the survival rate (P>0.05).

Discussion

The objective of this research was to evaluate and compare the success rates of pit and fissure sealant (PFS) treatments administered by undergraduate dental students and postgraduate students specializing in pediatric dentistry. To the best of our knowledge, there are no existing studies that investigated the success and longevity of PFS treatments carried out by undergraduate and postgraduate dental students, as well as the factors that could influence these outcomes.

This study evaluated 497 teeth belonging to 227 patients (135 girls and 92 boys), out of which, 408 teeth had undergone PFS treatments by undergraduate dental students, and 89 by postgraduate students in pediatric dentistry. This difference in the number of teeth treated by undergraduate and postgraduate students is due to the higher number of undergraduate dental students (n=176) compared to postgraduate students in pediatric dentistry

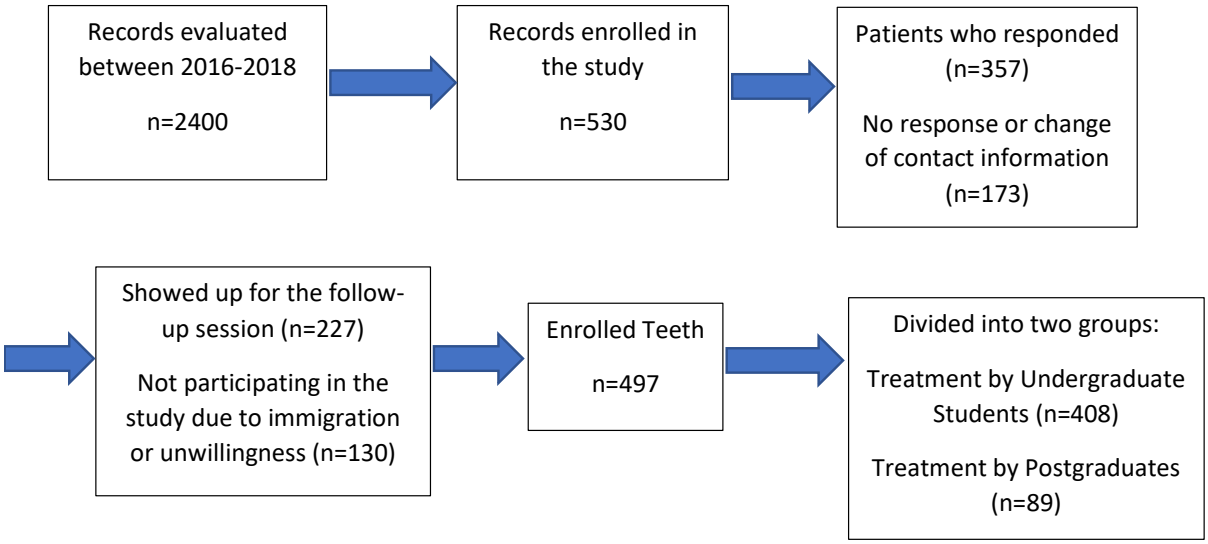
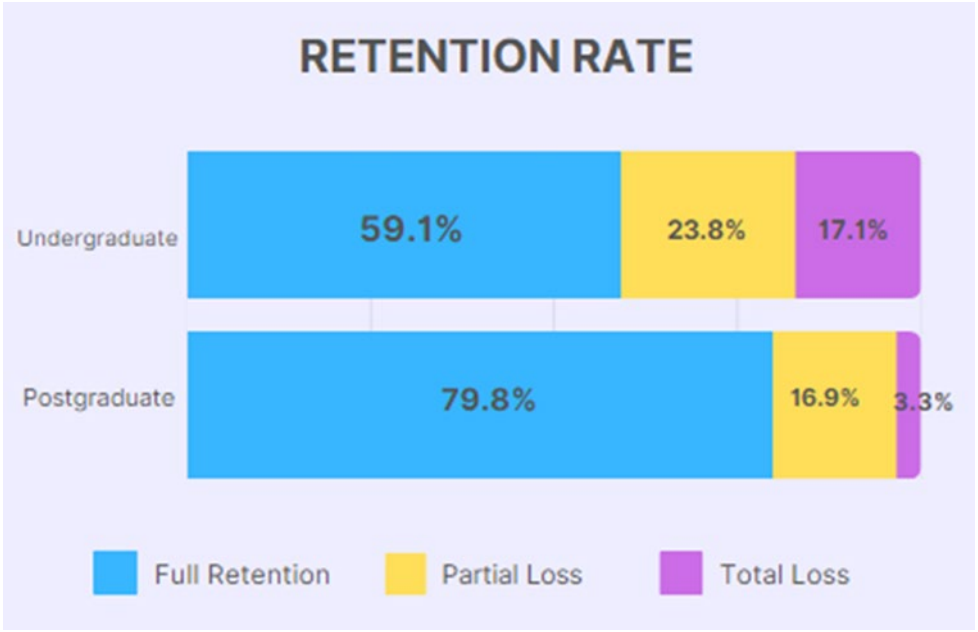
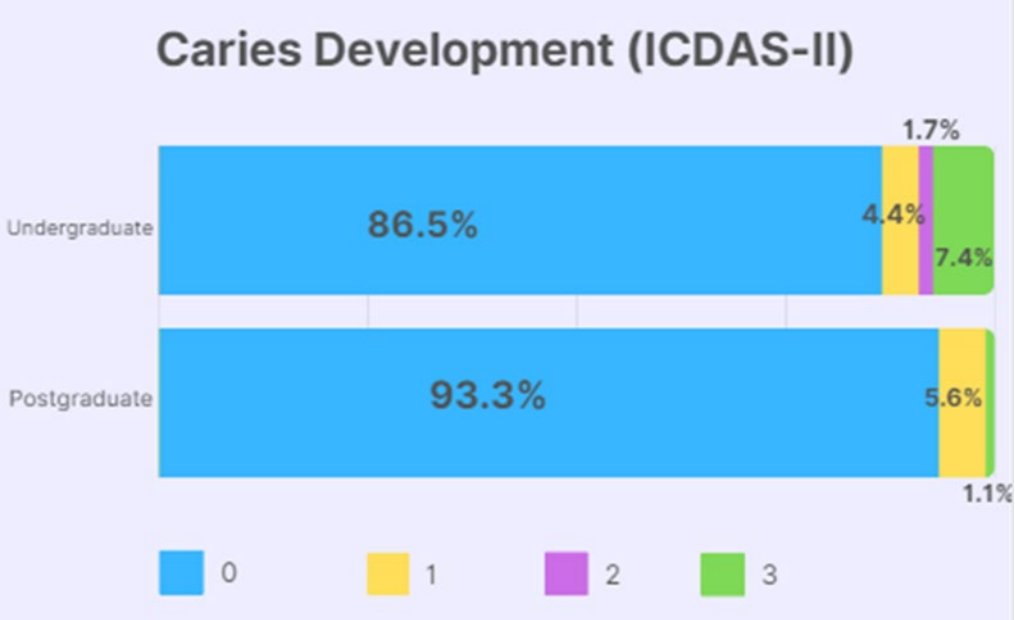


Figure 1. Flow diagram of patients enrolled in this study



	Full Retention (N)	Partial Loss (N)	Total Loss (N)
Undergraduate	241	97	70
Postgraduate	71	15	3

Figure 2. The Percentage (%) and number (N) of teeth showing full retention, partial loss, or total loss after PFS therapy by undergraduate students or postgraduate students in pediatric dentistry



	0 (N)	1 (N)	2 (N)	3 (N)
Undergraduate	353	18	7	30
Postgraduate	83	5	0	1

Figure 3. The Percentage (%) and number (N) of sound and carious teeth according to ICDASII scores 0-3 [0=Sound tooth surface: No evidence of caries after 5 seconds of air drying, 1=First visual change in enamel: Opacity or discoloration (white or brown) is visible at the entrance to the pit or fissure and is seen after prolonged air drying, 2=Distinct visual change in enamel: When wet there is a carious opacity (white or brown); the lesion must still be visible when dry, 3=Localized enamel breakdown: The breakdown is seen when the tooth is wet and after prolonged drying without clinical signs of dentin involvement.

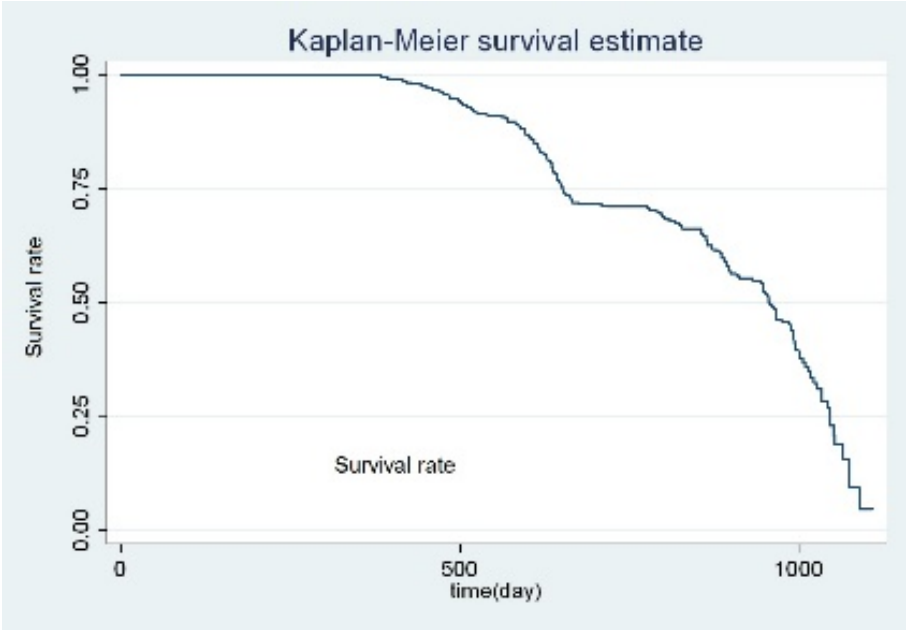


Figure 3. The Kaplan-Meier analysis of survival for fissure sealant treatment (the outcome was a fissure sealant treatment with full retention and ICDASII score=0)

(n=10). Postgraduate students in pediatric dentistry often perform more complex treatment procedures for younger uncooperative or anxious children, whereas simpler procedures, such as PFS treatment for cooperative and older children are often performed by undergraduate dental students.

In this study, the 3-year survival rate of PFS treatment was reported to be 32%. In a review study, Simonsen et al. estimated the failure rate of PFS therapy as 5-10% per year. (22) Thus, it seems that the obtained value in the present study was lower than the reported rate. It should be noted that clinical trials are often performed by expert and experienced clinicians under ideal conditions (25), whereas, in our study, most treatments were performed by undergraduate dental students. The key reason for the failure of PFS therapy is the loss of sealant retention due to inadequate isolation during the treatment process. This can result from an improperly fitted clamp and rubber dam, incomplete tooth eruption, suboptimal cooperation from the child, or contamination of the etched enamel with saliva or gingival crevicular fluid (19, 26). Moreover, the type of sealant material, preparation of fissures, experience and expertise of the operator, fissure type, and use/no use of adhesive can also impact the success rate of treatment (1, 3, 27-30).

In the present study, the success rate of treatment (odds ratio=2.3; 95% CI: 1.12-4.71; P=0.02), and the survival rate of treatment (time ratio=1.09; 95% CI: 1.01-1.18; P=0.01) were significantly higher in the postgraduate group than the undergraduate group. Evidence shows that under similar conditions, experience is an important factor that contributes to the clinical success of dental treatments (31). The standard protocol and utilized material were the same for PFS procedures performed by undergraduate and postgraduate students in the Department of Pediatric Dentistry of Mashhad Dental School. The mentors and instructors were also the same for both groups of practitioners. Thus, it seems that the level of operators' clinical experience is the most influential factor in the obtained results. Regular periodic follow-ups are another major factor in the long-term success of PFS treatment (9). Postgraduate students in pediatric dentistry often schedule regular follow-ups for their patients to monitor their course of treatment. Furthermore, postgraduate students in pediatric dentistry have higher expertise in behavioral guidance of pediatric patients and better adhere to the standards of treatment, which contributes to a higher success rate (32). In contrast, Nilchian et al. reported that the survival and success rates of PFS treatments did not depend on the operator, and these variables were similar in the dental clinicians and dental care professionals (17). Dental clinicians and dental care professionals in the study of Nilchian et al. (17) had a high level of experience, whereas undergraduate dental students in the current study had less experience than postgraduate students.

We also evaluated the age of patients at the time of treatment, gender, caries risk, OHI-S, DMFT, and dmft to assess the effect of patient-related factors on the success and survival rate of PFS treatment. Of 227 patients who participated in this study, 64.3% were at high risk of caries. Evidence showed that patients at high caries risk levels can better benefit from PFS compared to those with low risk of caries. Reviews published in recent years have mentioned high caries risk as an indication for PFS treatment (6, 9, 33). The outcomes of this study showed that the odds of success and survival of PFS treatment were not significantly different between high-caries risk and low-caries-risk patients. However, children with moderate caries risk displayed significantly lower success and survival rates of PFS treatment than those with low risk of caries. Oulis et al. (21) stated that retention loss and caries development more commonly occur in high-risk individuals after PFS treatment. This statement highlights the importance of follow-ups for patients with a moderate or high risk of caries. This should be taken into account when treating these patients in educational settings where the dental students who performed the treatment may not be present for the follow-up of patients.

According to the present results, an increased dmft significantly decreased the survival rate of PFS treatment. Other studies also demonstrated that increased dmft was associated with a higher failure rate of PFS treatment (21, 34). Furthermore, a strong association has been noted between caries prevalence in primary teeth with the occurrence of incipient caries in permanent first molars (21).

Like permanent teeth, primary teeth can benefit from the advantages of PFS treatment (9). The current results showed that the success rate, the odds of treatment success, and the survival rate of PFS treatment in primary teeth were significantly higher than in permanent teeth, which was in contrast to the findings of a summary review by Gugnani et al. (35). This discrepancy could be attributed to the operator's level of experience, given that a larger percentage of primary teeth were treated by postgraduate students, who had higher successful treatments than undergraduate students.

Previous studies demonstrated that the retention of PFS treatment is an important factor in determining its long-term success (9, 20, 28, 36), and reported a correlation between retention loss and risk of caries development in

the same tooth (37). However, Mickenautsch and Yengopal (37, 38) concluded that retention loss of sealants is not a good predictor for caries development in the future and should not be considered a clinical failure of PFS treatment. According to the current results, the retention rate of PFS treatments was 79.8% in the postgraduate and 59.1% in the undergraduate group, whereas the frequency of sound-treated tooth (ICDASII-0) in the follow-up session was 93.3%, and 86.5%, respectively. These findings indicated that, despite the retention loss of PFSs, carious lesions did not develop even in cases with a high risk of caries, which is in agreement with the results of Mickenautsch and Yengopal (37, 38). One possible explanation could be the presence of PFS in the deep areas of pits and fissures, which may not be clinically detectable but would still prevent caries. The lower retention rate in the undergraduate group may be attributed to their lack of experience in treating children, as providing dental care for children is more complex and requires greater experience (1, 39).

One of the limitations of the present study was the relatively low response rate of patients to attend follow-up appointments. This lower rate may be attributed to various factors such as patients who changed their phone numbers, immigrated to another city, or were reluctant to attend follow-up visits due to long travel distances or a lack of awareness regarding the importance of the study purpose. Furthermore, the three-year follow-up may be considered a short time for evaluating the success of fissure sealant treatments. Hence, further studies with longer follow-up periods are suggested to assess the success rate of PFS treatment performed by dental students.

Conclusions

Within the limitations of the present study, the following conclusions can be drawn:

1. The success and survival rates of PFS treatments in the postgraduate group were significantly higher than those in the undergraduate group ($P<0.05$).

2. Moderate caries risk and permanent tooth type were significantly associated with a lower success rate of PFS therapy, whereas, increased dmft, moderate caries risk, and permanent tooth type were associated with shorter survival times.

3. PFS treatment is assumed to be more successful when performed by postgraduate students in the primary teeth of patients with low caries risk.

Conflict of interest

The authors have no conflicts of interest to declare.

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