Removal of Organic Debris from Occlusal Fissures: Advantage of Carisolv System over Sodium Hypochlorite

Yoshishige Yamada */ Mozammal Hossain **/ Yuichi Kimura***/ Yoshiko Masuda ****/
Jayanetti Asiri Jayawardena *****/ Yuya Nasu ******

Objective: *The purpose of this in vitro study was to evaluate and compare the removal of artificial debris from pits and fissures using the Carisolv system and sodium hypochlorite.* ***Study design:*** *Forty artificial fissures prepared on extracted human teeth were filled with artificial organic debris. Debris was removed using either Carisolv or 10% sodium hypochlorite gel. After stereoscopic observation, samples were filled with a sealant and subjected to microleakage test.* ***Results:*** *Both Carisolv and sodium hypochlorite demonstrated adequate cleaning ability and prevention of microleakage. Although both Carisolv and 10% sodium hypochlorite are effective at removing debris from fissures, Carisolv presents greater advantages in terms of safety and antibacterial properties.* ***Conclusion:*** *Fissure cleaning using Carisolv might be an effective approach to improve the retention of fissure sealants.*

Keywords: *fissure cleaning, Carisolv, sodium hypochlorite, microleakage test.*
J Clin Pediatr Dent 35(1): 75–80, 2010

INTRODUCTION

Occlusal pits and fissures, which have complex anatomical features, tend to retain plaque and account for more than 85% of all caries-affected surfaces.[1,2] Fissure sealants were introduced as a means to prevent these types of dental caries. Although several reports have demonstrated the effectiveness of fissure sealants for preventing caries,[3,4] a few researchers showed poor retention due to fracture or dislodgement of sealants.[5,6] One of the keys to successful sealant retention is effective cleaning of pits and fissures before application of the sealant. García Godoy *et al* reported that clean fissure grooves at the time of sealant placement are necessary to achieve adequate retention of a sealant.[7] In clinical settings, conventional techniques such as prophylaxis with pumice, air-abrasion,[10] or Er:YAG laser[11] are sometimes used for cleaning the fissures, although they are not always effective. Therefore, the persistence of plaque or organic debris following routine cleaning and etching might affect sealant retention.[8,9]

Chemo-mechanical caries removal systems such as GK-101[12] and Carisolv[13] have been analyzed for their effectiveness in removing debris. Carisolv, which contains sodium hypochlorite (NaOCl) and three kinds of amino acids (glutamic acid, leucine, and lysine), is considered one of the most effective systems in the dental clinic for removing caries.[14] Yamada *et al* demonstrated that Carisolv can remove organic components in pits and fissures more effectively than conventional cleaning with a bristle brush.[13]

The aim of the present study was to compare the effectiveness of the Carisolv system to that of NaOCl in removing artificial organic debris.

MATERIALS AND METHODS

Preparation of Fissure Grooves

Forty extracted human permanent teeth with intact occlusal surfaces were used in the present study, after obtaining consent from the patients. These teeth, which had been extracted for orthodontic or periodontal reasons, were brushed and washed with distilled water at room temperature. Artificial fissure grooves (width: 1 mm, depth: 1 mm in enamel) were then prepared on the occlusal surface of each tooth using a 1/4 round carbide bur (Mani Inc., Tochigi,

* Yoshishige Yamada, DDS, PhD, lecturer, Department of Endodontology, Showa University School of Dentistry.
** Mozammal Hossain, BDS, PhD, visiting professor, Department of Endodontology, Showa University School of Dentistry.
*** Yuichi Kimura, DDS, PhD, professor, Division of Endodontics, Department of Conservative Dentistry, Ohu University School of Dentistry.
**** Yoshiko Masuda, DDS, PhD, lecturer, Department of Endodontology, Showa University School of Dentistry.
***** Jayanetti Asiri Jayawardena, BDS, PhD, Assistant Professor, Department of General Education, Tsurumi University School of Dental Medicine.
****** Yuya Nasu, DDS, Assistant professor, Department of Endodontology, Showa University School of Dentistry.

Send all correspondence to Yoshishige Yamada, Department of Endodontology, Showa University School of Dentistry, 2-1-1 Kitasenzoku, Ohta-ku, Tokyo 145-8515, Japan

Phone: (81)3-3787-1151 (Ext 247)
Fax: (81)3-3787-1229,

Email: yyamada@dent.showa-u.ac.jp

Japan) on a high speed handpiece following a method used in a previous report.[15]

Preparation of Artificial Organic Debris

Artificial organic debris was prepared according to the method described by Yamada *et al*[13] and consisted of 20% Liquitex (Liquitex acrylic soft; Liquitex Co., OH, USA), 30% Starch gruel (Fueki-ko; Fueki Co., Yao, Japan), 30% Poster color (Poster color super; Sakura Co., Osaka, Japan), and 20% solid food fragments (MR-stock; Nihon-Nosan Co., Yokohama, Japan). These ingredients, which were originally used for rats, were mixed together in order to simulate the clinical condition. Fissures were then filled with this artificial organic debris.

Experimental Procedure

The teeth were randomly divided into 2 groups of 20 each. Fissures of the teeth in one group were pre-treated using Carisolv (Medi Team, Göteborg AB, Sweden). The Carisolv gel used in this study had two separate components, as supplied by the manufacturer. These components were mixed in a container prior to use and subsequently applied to the artificial fissure for 30 seconds, gently inserted with a dental explorer, and rinsed afterwards with water spray. The remaining 20 teeth were cleaned with 10% NaOCl gel (AD gel; Kuraray Medical Inc, Tokyo, Japan). All teeth were then dried with oil-free compressed air for 20 seconds.

Assessment during Fissure Cleaning

Cleaning fissures by each of the methods was continued until artificial organic debris was completely removed or for a maximum 3 minutes. The time period required for fissure cleaning was recorded for each treatment method.

Characteristics of the Treated Surfaces

All treated fissures were acid-etched and then examined macroscopically to verify the surface characteristics using a stereoscope (SMZ-10; Nikon Co., Tokyo, Japan). Each fissure was assessed and, depending on the degree of cleaning, divided into four levels: Level 1; no debris remaining, Level 2; presence of debris covering 25% of the surface area of the fissure, Level 3; presence of debris covering 25–50% of the surface area of the fissure, and Level 4; presence of debris covering over 50% of the surface area of the fissure. After examining the fissure surface, each fissure was filled with sealant material (Teethmate® F-1 2.0; Kuraray Medical Inc., Tokyo, Japan) following the manufacturer's instructions. Finally, the sealant material was light-cured for 30 seconds. A microleakage test was performed according to a protocol used in a previous study.[13] All the teeth surfaces except for the areas filled with sealants and 1 mm outside the margins of the fissures were double-coated with nail varnish. The samples were then thermocycled for 600 cycles between 5°C (± 2) and 55°C (± 2) with a 1 minute-dwell time at each temperature, and immersed for 4 hours in a Rhodamine buffered dye solution. The samples were then transversely bisected with a diamond saw disc (IsoMet; Buehler, IL, USA), and the degree of microleakage using dye penetration was scored based on a grade-scale criteria (Table 1) under a microscope by a technician who was blinded to the true nature and purpose of the experiment. In cases where the scores were different between the bisections, the lesser score was used in the evaluation.

Statistical Analysis

Statistical analysis was performed using the Mann Whitney U test and a value of $P < 0.05$ was considered significant.

RESULTS

The duration of treatment using Carisolv and the NaOCl solution was 130 ± 25 seconds and no statistical significance between the two groups was observed ($P > 0.05$). Photographs of the stereoscopic examination of the Carisolv-treated surfaces are shown in Figure 1. The preoperative view is shown in Figure 1a, and the fissure following treat-

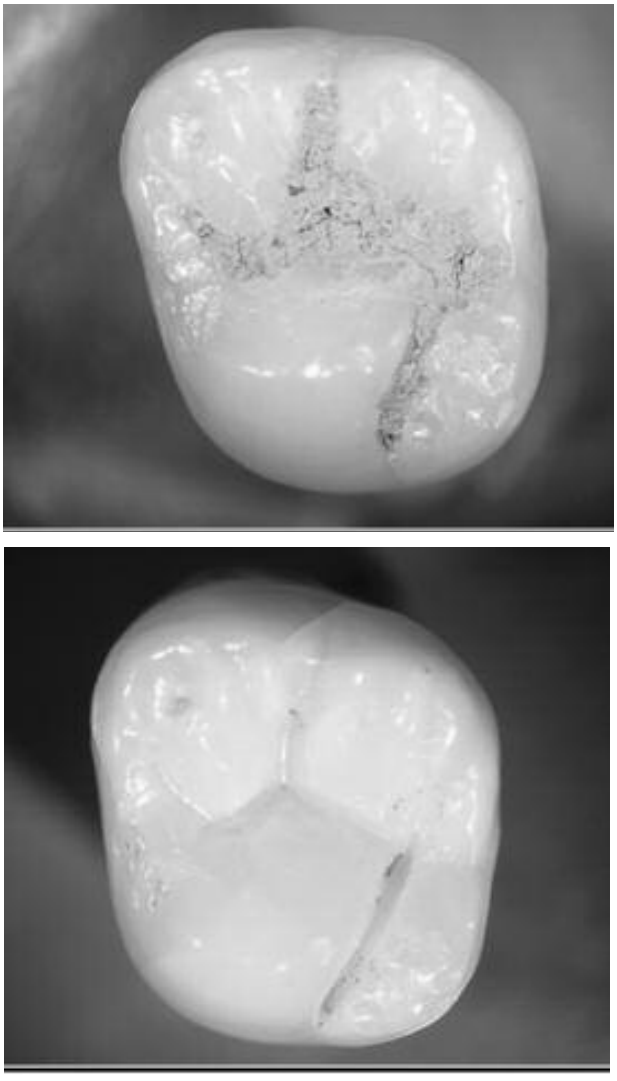

Figure 1
(a) Preoperative view of occlusal surface. The fissure groove is filled with artificial organic debris.
(b) View after Carisolv treatment. No remaining debris is observed.

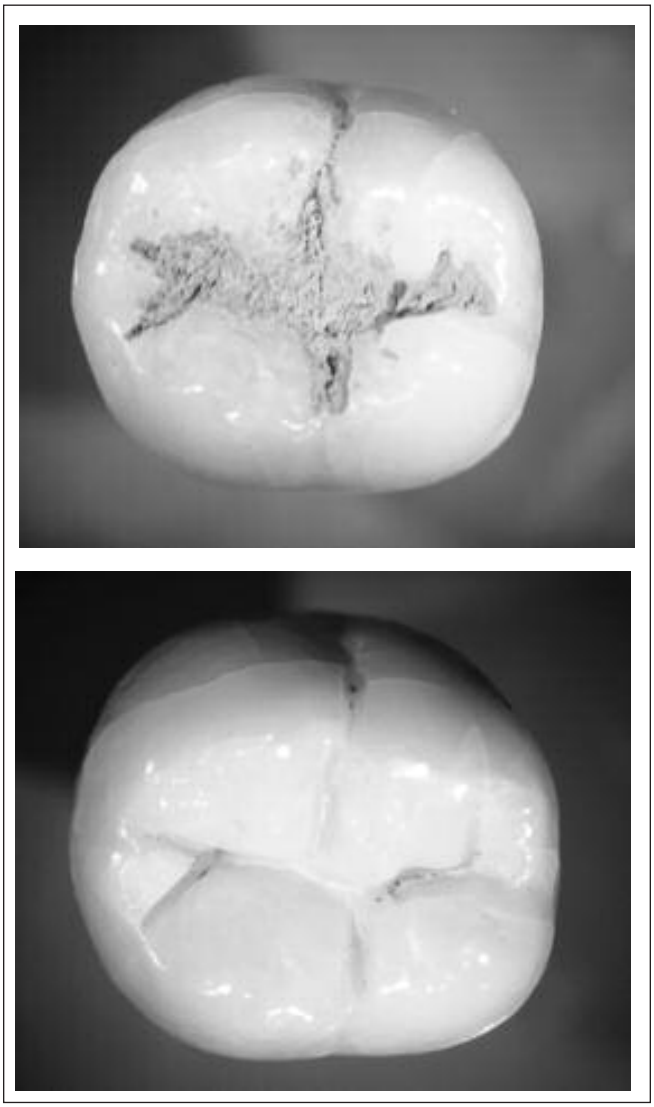

Figure 2
(a) Preoperative view of occlusal surface.
(b) View after NaOCl (AD gel) treatment.

Table 1. Microleakage score

Score	Contents
0	No dye penetration
1	Dye penetration restricted to the outer half of the sealant
2	Dye penetration to the inner half of the sealant
3	Dye penetration into underlying fissure

ment by Carisolv is shown in Figure 1b. Carisolv treatment did not widen or deepen fissure grooves; treated surfaces were smooth and regular. The wall and floor of the cavities were flat and nearly devoid of debris. The stereoscopic observations of fissures after NaOCl treatment are shown in Figure 2. A preoperative view is shown in Figure 2a, and a post-treatment view is shown in Figure 2b. The post-treatment appearance of the fissures was comparable between Carisolv and NaOCl, exhibiting smooth and regular surfaces in both cases. Assessment of the remaining debris in fissures of all samples is indicated in Table 2. In summary, the debris remaining in fissures were comparable after both Carisolv and NaOCl treatments. Most fissures showed little or no debris remaining, and heavy deposits of debris were not present in any of the fissures.

Table 2. Condition of fissure grooves after cleaning

Treatment	No debris (Level 1)	Light coverage of debris (Level 2)	Moderate cover of debris (Level 3)	Heavy coverage of debris (Level 4)
NaOCl	13	5	2	0
Carisolv	12	7	1	0

The results of the microleakage investigation after Carisolv treatment are shown in Figure 3a, and those after NaOCl treatment are shown in Figure 3b. Stereoscopic observation of these samples revealed good adaptation of the

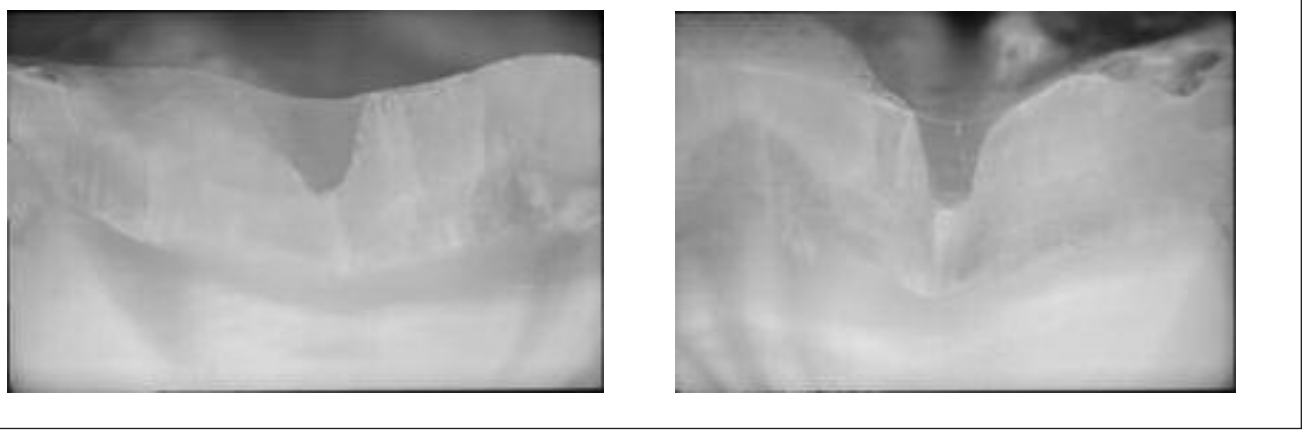

Figure 3
(a) Sagittal section after microleakage test in the Carisolv-treated group. No specific penetration of staining was observed.
(b) Sagittal section after microleakage test in the NaOCl-treated group. No specific penetration of staining was observed.

sealant to enamel. The microleakage scores found in this study are presented in Table 3; no significant difference was observed between the two groups (P > 0.05).

Table 3: Results of microleakage test

Treatment	0	1	2	3	(mean ± SD)
NaOCl (n=20)	18	1	1	0	0.15 ± 0.49[a]
Carisotlv(n=20)	17	2	1	0	0.20 ± 0.52[b]

*[ab]No significant difference was found (P > 0.05)

DISCUSSION

Natural pits and fissures in occlusal surfaces of teeth are complex as they vary in depth, width, and anatomical features. Therefore, in order to standardize the samples for comparison, artificial fissures in the enamel, to a depth of 1 mm, were prepared in the present study. This study model was adopted from a previous study[15] conducted by our research group and thereafter, several other researchers have also reported evaluation of fissure cleaning after mechanical preparation of occlusal fissures.[16,17,18] The present study thus adopted this model for comparing organic debris removal using Carisolv and 10% NaOCl.

Carisolv, which contains NaOCl, acts as both a solvent of organic materials and as a sterilizing agent. Recently, Roberto *et al*[19] reported that NaOCl enhances acid etching of enamel, because of its improved elimination of organic components. According to Yamada *et al*,[13] Carisolv is able to clean fissures of debris. The present study demonstrated that 10% NaOCl is also capable of cleaning the fissures. Furthermore, the results of microleakage tests indicate that the cleaning of fissures by 10% NaOCl prevents leakage from marginal walls, similar to Carisolv treatment. As for the debris score after fissure cleaning and microleakage tests, there was no significant difference between the results of the two methods. Although our research group attempted to use 1% and 5% NaOCl solution initially, removal of organic debris from fissures was not satisfactory. Therefore, a 10% NaOCl solution was prepared for this study. Moreover, it was difficult to keep the original NaOCl solution in the fissure because of its fluidity, therefore AD gel was chosen for the present study. To increase the viscosity and to facilitate application to the fissure the AD gel a thickener (alumina micro filler) was incorporated into the AD gel. It has been reported that improved fissure cleaning was achieved following the use of AD gel before sealant application.[20] Although the effectiveness of 10% NaOCl was demonstrated in this study, 10% NaOCl seems to be too strong for use in the dental clinic, and the risk of damage to surrounding soft tissue cannot be ignored from a clinical point of view. It has already been argued that NaOCl might be cytotoxic to the surrounding soft tissues of teeth.[21,22] It is known that NaOCl has no demineralizing effect on sound enamel; however care must be taken not to drop it on surrounding soft tissues during application. This is especially important in children in whom fissure sealants are mainly applied and during treatment when it is not uncommon for the young patients to move suddenly. Taking these factors into consideration, safer preparations of NaOCl should be applied to children.

On the other hand, Carisolv may be safer than sodium hypochlorite because Carisolv contains only a low percentage of NaOCl (0.5%) in addition to three amino acids (lysine, leucine, and glutamic acid). Ericson reported two advantages of Carisolv; reduction of the aggressive effect of sodium hypochlorite on sound tissue and no demineralizing effects on enamel**.** Therefore, Carisolv could be safely applied for fissure cleaning. In addition, on mixing sodium hypochlorite and the three amino acids, chloramines were produced. Chloramines are created by the chemical reaction of ammonia and NaOCl under alkaline conditions and have been shown to. possess antibacterial properties and be influenced by solution pH.[23]

A previous report demonstrated that the acid-etching procedure itself markedly reduced viable microorganisms, although few of them still remained in the fissures after the procedure.[24] Thus, Chloramines in Carisolv method may effectively reduce the presence of microorganisms in the fissures by its own sterilizing effect. Consequently, the results of using Carisolv suggested that it can impart better retention of the sealant. In contrast to NaOCl, Carisolv seems to have several benefits when used for fissure cleaning. Although the cost-effectiveness of Carisolv in clinical dentistry still remains to be improved, it has proved to be safe and efficient for fissure cleaning. Hence, this new method of fissure cleaning using Carisolv might be more effective in improving retention of fissure sealants.

CONCLUSION

Clean fissures are important in maintaining the retention of fissure sealants.

This study has shown that high concentrations of NaOCl are not required for removing organic debris. Therefore, Carisolv may be a good candidate for fissure cleaning since it contains a low concentration of NaOCl and produces chloramines, which are effective antibacterial agents.

ACKNOWLEDGEMENTS

This study was supported in part by a Grant-in-Aid for Scientific Research (C) (No. 20592235) from the Japan Society for the Promotion of Science (JSPS).

REFERENCES

1. Vehkalahti MM, Solavaara L, and Rytömaa I. An 8-year following-up of the occlusal surfaces of first permanent molars. J Dent Res, 70: 1064–1067, 1991.
2. Hicks MJ and Flatiz CM. Epidemiology of dental carried in pediatric and adolescent population: A review of past and current trends. J Clin Pediatric Dent, 18: 43–49, 1993.
3. Kramer PF, Zelante F and Simionato MRL. The immediate and long-term effects of invasive and noninvasive pit and fissure sealing techniques on the microflora in occlusal fissures of human teeth. Pediatr Dent, 16: 108–112, 1993.
4. Ripa LW. Sealant revisited: An update of the effectiveness of pit-and-fissure sealants. Caries Res, 27: 1 77–182, 1993;.

5. Jensen OE, Handelman SL and Perez-Diez F. Occlusal wear of four pit and fissure sealants over two years. Pediatr Dent, 7: 23–29,1985.
6. Wendt L-K, Koch G. Fissure sealant in permanent first molars after 10 years. Swed Dent J, 12: 181–185,1988.
7. García-Godoy F, Gwinnett AJ. Penetration of acid solution and gel in occlisal fissures. J Am Dent Assoc, 114: 809–810, 1987.
8. Futatsuki M, Kubota K, Yeh YC, Park K and Moss SJ. Early loss of pit and fissure sealant: a clinical and SEM study. J Clin Pediatr. Dent, 19: 99–104,1995.
9. Burrow MF, Makinson OF. Pits and fissures: remnant organic debris after acid-etching. J Dent Child, 57: 348–351, 1990.
10. Blackwood JA, Dilley DC, Roberts MW, Swift EJ Jr. Evaluation of pumice, fissure enameloplasty and air abrasion on sealant microleakage. Pediatr. Dent, 24: 199–203, 2002.
11. Borsatto MC, Corona SA, Dibb RG, Ramos RP, Pecora JD. Microleakage of a resin sealant after acid-etching, Er: YAG laser irradiation and air-abrasion of pits and fissures. J Clin Laser Med Surg, 19: 83–87, 2001.
12. Ohmori I, Kunimoto H, Takeuchi K, Ibata K, Sasaoka K. A clinical study on the effect of the GK-101 irrigation on the sealant retention for controlling the incipient pit and fissure caries. Jpn J Ped Dent, 21: 169–178, 1983.
13. Yamada Y, Hossain M, Kimura K, Nakamura Y, Masuda Y, Simizu Y, Matumoto K. Artificial plaque removal with Carisolv system: a clinical approach. J Clinc Pediatric Dent, 31: 199–201, 2007.
14. Ericson D, Zimmerman M, Raber H, Götrick B, Bornstein R, Thorell J. Clinical evaluation of efficacy and safety of a new method for chemomechanical removal of caries. A multi-centre study. Caries Res, 33: 171–177, 1999.
15. do Rego MA, de Araujo MAM. Microleakage evaluation of pit and fissure sealants done with different procedures, materials, and laser after invasive technique. J Clin Pediatr Dent, 24: 63–68, 1999.
16. Shapira J, Eidelman E. The influence of mechanical preparation of enamel prior to etching on the retention of sealants: Three year follow-up. J Pedodont, 8: 272-–274, 1984.
17. De Craene GP, Martens C, Dermaut R. The invasive pit-and-fissure sealing technique in pediatric dentistry: An SEM study of a preventive restoration. J Dent Child, 55: 34–42, 1988.
18. García Godoy F, Araujo FB. Enhancement of fissure sealant penetration and adaptation: The enameloplasty technique. J Clin Pediatr Dent, 19: 13–18, 1994
19. Espinosa R, Valencia R, Uribe M, Ceja I, Saadia M. Enamel deproteinization and its effect on acid etching: An *in vitro* study. J Clinc Pediatric Dent, 33: 13–19, 2008.
20. Nakajima Y, Idaria Y, Yasosima H, Ohmori I. Clinical evaluation of a fluoride releasing resin sealant. Jpn J ped Dent, 39: 103–109, 2001.
21. Gernhardt CR, Eppendorf K, Kozlowski A, Brandt M. Toxicity of concentrated sodium hypochlorite used as an endodontic irrigant. Int Endod J, 37: 272–280, 2004.
22. Gatot A, Arbelle J, Leiberman A, Yanai-Inbar I. Effects of sodium, hypochlorite on soft tissues after its inadvertent injection beyond the root apex. J Endod, 17: 573–574, 1991.
23. Tonami K, Araki K, Mataki S, and Kurosaki N. Effects of Chloramines and sodium hypochlorite on carious dentin. J Med Dent Sci, 50: 139–146, 2003.
24. Paulo FK, Flavio Z, Maria Regina LS. The immediate and long-term effects of invasive and noninvasive pit and fissure sealing techniques on the microflora in occlusal fissures of human teeth. Pediatric Dent, 16: 108–112, 1993.