EGYPTIAN
DENTAL JOURNAL
www.eda-egypt.org

Vol. 71, 977:984, January, 2025

Print ISSN 0070-9484 • Online ISSN 2090-2360

Conservative Dentistry and Endodontics

Submit Date : 09-12-2024 • Accept Date : 27-12-2024 • Available online: 10-01-2025 • DOI : 10.21608/edj.2024.342961.3297

COMPARATIVE EVALUATION OF THE BOND STRENGTH OF RESIN COMPOSITE TO CARIES AFFECTED DENTIN TREATED WITH CHEMOMECHANICAL METHOD (PapaCarie) AND Er,Cr:YSGG LASER: AN IN-VITRO STUDY

Inas El Zayat *, Mohamed Bahgat Abdel Hamid **, Ahmed Tarek Farouk ** *and* Youssef Sedky ***

ABSTRACT

Aim: to evaluate the impact of using Er,Cr:YSGG Laser and chemomechanical method (PapaCarie) on the microshear bond strength of resin composite to caries affected dentin.

Materials and Methods: Twenty-Seven freshly extracted human mandibular molars with deep occlusal caries were selected for this study. Selected teeth were embedded in acrylic blocks with their clinical crowns exposed, then cross-sectioned horizontally leaving a flat carious dentin surface. They were then randomly assigned into three equal groups (n=9) according to the treatment method used. Group (1) (PapaCarie group): caries removal was done using chemomechanical method), Group (2) (Laser group): Er,Cr:YSGG laser was used for removal of caries, and Group (3) caries removal was done using the conventional excavation technique. Bonding protocol was applied to all teeth following the manufacture's instruction, followed by application of resin composite to the exposed dentin. Microshear bond strength was immediately evaluated using a universal testing machine.

Results: One-way ANOVA test showed that there was no statistically significant difference between the three groups (P-value <0.05). Group 1 (PapaCarie group) showed the highest microshear bond strength mean value (25.31 MPa), followed by Group 2 (laser group) with mean value (24.46 MPa), with the lowest value for the Group 3 (conventional group) 23.98 MPa with no significant difference between the groups.

Conclusions: PapaCarie showed promising results in terms of bond strength to caries affected dentin. But still Er,Cr:YSGG laser could provide comparable satisfactory results.

KEYWORDS: Chemomechanical method (PapaCarie), Er,Cr:YSGG laser, Caries affected dentin, Microshear bond strength.

* Associate Professor, Restorative department, Faculty of Oral & Dental Medicine, Misr International University
** Lecturer, Restorative department, Faculty of Oral & Dental Medicine, Misr International University
*** Assistant Professor, Orthodontic department, Faculty of Oral & Dental Medicine, Misr International University

INTRODUCTION

Standard methods of cavity preparation such as excavation, high-speed &slow rotating handpieces and sharp-edged hand instruments generally elicit pain, annoying sounds, vibration as well as the complete destruction of healthy tooth structure, causing the tooth to become weakened and threatening its long-term functional integrity. [1]

This method has also been recently introduced as an alternative to the conventional method of caries removal in the form of a chemomechanical caries removal agent which is claimed to be painless minimally invasive non-traumatic method of caries removal. It was first introduced by Habib et al. in 1975. efficient in removal of infected dentine by using 5% sodium hypochlorite, after this two materials caridex system and Carisolv were[2] launched on market. [2-7] However, considering their drawbacks like short shelf life, corrosive, instrument requirement, unpleasant taste and expensive; they could not achieve the requisite popularity among dentists. In 2003, a next-generation revolutionary product came to Brazil under the commercial name of PapaCarie. [2,3,8]. PapaCarie is a papain-based gel. Papain is a peptic cleaving enzyme similar to the human pepsin. It also interferes with the partially denatured collagen fibrils and softens the infected dentin making it removable by blunt hand instruments. [9] In comparison with other chemo-mechanical caries removal agents like Carisolv, it is cost-effective. It is not instrumentally determined, therefore more chances to be globally applied. [10]

However, the laser wavelengths used in laser ablation systems for caries removal produce a significant interaction with the mineral, water content, or both in the degraded tissues. The main mechanism of action in the most widely used caries removal systems is the heating of the water at the surface and underneath, which causes the water to expand and blast the tissue out from the surface. [11–13] Er:YAG (Erbium-doped Yttrium Aluminum Garnet) and Er, Cr: YSGG (Erbium, Chromium-doped Yttrium, Scandium, Gallium, and Garnet) lasers are the most widely utilized laser systems for caries eradication.

The shape and composition of the prepared dentin surface affect how well adhesive restorative materials adhere when dentin carious lesions are intervened. [3] Previous research hypothesized that the roughened surface produced by chemomechanical caries removal provides better conditions for resin penetration and micromechanical retention, leading to a stronger connection. [14,15,16] Additionally, it is well known that erbium lasers can increase the connection to tooth structure by removing the smear layer. [17]

Since the literature contains conflicting results, it is difficult to determine how employing chemomechanical and Er,Cr:YSGG Laser techniques affects the bond strength of resin composites when compared to traditional caries removal techniques. Therefore, the purpose of this study was to compare the effects of the traditional approach and the Er,Cr:YSGG Laser and chemomechanical method (PapaCarie) on the microshear bond strength of resin composite to affected dentine .

The null hypothesis of this study was that there is no difference between using Er,Cr:YSGG Laser, chemomechanical method (Papacarie) and the conventional method on microshear bond strength of resin composite to caries affected dentin.

MATERIALS AND METHODS

This study was conducted after the approval of the Research and Ethical committees at MIU and was given an IRB# MIU-IRB-2324-051.

Sample size calculation

Microshear bond strength was the main output of power analysis, which was utilized to calculate the overall sample size. Using an alpha (α) level of 0.05 (5%) and a beta (β) level of 0.20 (20%), the effect size (f) was 0.68, meaning that power = 80%; a minimum estimated sample size of 27 participants was required. The computation was predicated on the findings of an earlier investigation.[8]

There were nine patients in each group, for a total sample size of 27. To calculate the sample size, G*Power Version 3.1.9.2 was used.

Study design

The current in vitro study was conducted on a total of 27 freshly extracted human mandibular molars having frank cavitation of moderate size, acquired from Misr International University teeth bank.

Selection of samples:

The teeth included in this study, were freshly extracted mandibular molars, with deep occlusal caries.Carious lesions extending into the dentin were assessed with Dental Operating Microscope (Carl Zeiss OPMI PICO Surgical Microscope, Germany) and Radio-Visuo-Graphy (Kodak RVG 5100, Care Stream Health, Inc., NY, USA).

Preparation of samples:

Teeth were cleaned and scaled to remove any surface deposits and/or calculus and soft tissues and stored in distilled at room temperature. They were then mounted in standardized acrylic resin blocks using a mold with a dimension of 1 × 1 × 2.5cm with their clinical crowns exposed, then the occlusal enamel surface of each tooth was removed using an automated diamond saw machine (Isomet 4000, Buehler Ltd., Germany), under running water to expose a flat carious dentin surface. The carious dentin surfaces were smoothed using a 600-grit silicon carbide paper under wet condition for 10 seconds, then all teeth were again stored in distilled water at room temperature until the time of use.

Grouping of samples:

Teeth were randomly divided into three equal groups (n=9) according to the caries removal method used:

Group 1: PapaCarie gel (Formula & Acao 04106-001 Sao Paulo, Brazil) was utilized in the chemomechanical approach of caries elimination. Ten minutes prior to usage, the 3 ml gel syringe was removed from the refrigerator, inserted into the cavity until it was easily filled, and then left for 60 seconds. The gel was clear first applied, but as the lesion broke down, it became turbid. A blunt spoon excavator was used to scrape away the softened, diseased dentin (71-72 Maillefer, Switzerland). If a darkening hue appeared, the gel was reapplied without the cavity being rinsed or dried in between applications. Until the gel was transparent, the process was repeated. Following a thorough soft caries excavation, sterile cotton pellets moistened in water were used to remove any remaining gel.

Group 2: Er,Cr:YSGG was used to remove caries at a wavelength of 2780 nm using WaterLase iplus, Biolase. The power was 5.5 W on average, the repetition rate was 20 Hz, the mode/H was 60 µs, the water was 80%, and the air was 60%. utilizing a non-contact 800 µm (MZ8) tip that is 2 mm distant.

Group 3: Under magnification, caries was removed using a round steel bur size 3 (Komet Dental, Trophagener Weg, Germany) and a low-speed handpiece (NSK, Tochigi, Japan). All of the teeth in this group were examined both visually and physically after the caries was removed in order to confirm the excavation procedure.

Bonding procedure:

The prepared specimens were carefully inspected to identify a level surface appropriate for the testing following caries excavation. Following manufacturer instructions, a microbrush (regular size, Shofu INC, Kyoto, Japan) applied a universal adhesive, Single Bond Universal adhesive (3M ESPE, St. Paul, MN, USA), to all prepared areas of specimens without any surface pretreatments. A PVC tube (internal diameter = 0.97 mm, 2 mm high) was then placed on the dentin surface and light-cured alongside the adhesive for 20 seconds using an LED light-curing device (Bluephase N, Ivoclar Vivadent, Schaan, Liechtenstein) set to 1200 mW/cm2. Prior to each group's restoration treatment, the light curing device was calibrated using a spectrophotometer (USB4000, Ocean Optics).

Beautifil Flow Plus X, F00 (Shofu INC, Kyoto, Japan) was poured into the tube, which was then withdrawn after 20 seconds of light curing. Before testing, all specimens were kept for 24 hours at 37°C in distilled water.

Microshear bond strength (μSBS) measurement

In a universal testing machine (DL 2000; Emic Sao Jose de Pinhas, PR, Brazil), the bonded interface was put through μSBS testing using a loop of ligature wire (Unitex, diameter 0.009 inches, TP Orthodontics, Leeds, UK) that applied a force parallel to the bonded surface at a crosshead speed of 1.0 mm/min. The following formula was used to determine the μSBS values for each specimen: Microshear bond strength (MPa) = shear force (N)/cross-sectional area (mm^2).

Statistical analysis:

Every piece of information was gathered, tallied, and statistically examined. By examining the data distribution and applying the Shapiro-Wilk and Kolmogorov-Smirnov tests, numerical data were examined for normality. The distribution of all the data was parametric, or normal. The mean, standard deviation (SD), and 95% confidence range for the mean values were used to depict the data.

The three groups' mean microshear bond strength values were compared using a one-way ANOVA test. When the ANOVA test is significant, pairwise comparisons are conducted using Tuckey's post-hoc test.

A significant threshold of P<0.05 was established. IBM® SPSS® Statistics Version 20 was used to conduct the statistical analysis.

RESULTS

Table (1) and Figure 1 give descriptive statistics and comparison results of microshear bond strength in the three groups.

The results of the one-way ANOVA test indicated that the three groups did not differ statistically significantly (P-value <0.05). The microshear bond strength mean value for Group 1 (PapaCarie group) was the highest at 25.31 MPa, followed by Group 2 (laser group) at 24.46 MPa, and Group 3 (conventional group) at 23.98 MPa. with each group showing no significant variations.

TABLE (1). Descriptive statistics and results of One-way ANOVA test comparison between Microshear bond strength in the three groups

Immersion Media	Mean	SD	Range		P-value
			Lower bound	Upper bound	
Group 1 (PapaCarie group)	25.31	0.53	24.63	26.01	
Group 2 (Laser group)	24.46	0.85	23.21	25.61	0.110
Group 3 (Conventional group)	23.98	1.25	22.16	24.99	

: Significant at P ≤ 0.05, Different superscripts are statistically significant different

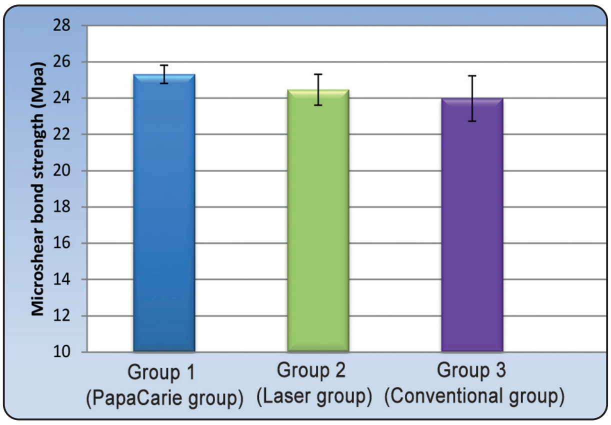

Fig. (1): Bar chart representing mean and standard deviation for Microshear Bond Strength in the three groups.

DISCUSSION

Among all oral illnesses, dental caries is one of the most prevalent dental diseases. [18] Geographical location and socioeconomic status affect its development and spread; when income declines, the number of untreated lesions tends to rise sharply. [19] Dental caries is the most prevalent non-communicable disease in the world, according to the World Health Organization (WHO). [20] Diet and oral flora are important factors in its complex pathogenesis. Tooth demineralization is caused by persistent low oral pH and acid generation by microbial breakdown of carbohydrates. If left untreated, the process can lead to pulp involvement, swelling, abscess, and systemic signs and symptoms. It begins as minor surface roughness or subsurface demineralization and continues until it reaches cavitation. [18, 19]

Traditional mechanical caries removal and cavity preparation techniques are frequently linked to discomfort and anxiety.[18] Even with effective local anesthetic pain management, the patient still experiences discomfort from noise, heat creation, vibration from the mechanical preparation, and needle phobia. Furthermore, by raising the temperature, these methods run the danger of deliterating the pulp or readily removing healthy dental tissues. [18]

Different strategies for managing deep caries have been addressed and taken into consideration in order to maintain tooth structure by simply removing the severely decayed dental tissues, which is compatible with the growing idea of minimally invasive dentistry. [21] Repetitive restorative cycles are avoided and tooth survival is often improved by these conservative methods. [21] Even though mechanical caries removal procedures are commonly recognized as being rapid and simple, a number of other therapeutic approaches, including chemo-mechanical methods, lasers, and sono/air abrasion, have shown promise. [22]

By applying compounds based on enzymes or sodium hypochlorite (NaOCl), chemo-mechanical caries removal systems work on the basis of softening carious tissue to make removal easier. [2-6] Once the gel is placed on the infected carious lesion, the chemical process begins. The gel turns turbid and discolored, and oxygen is released, creating bubbles that represent the completion of the collagen degradation response or the absence of any remaining decayed tissue. [2–6] Following the reaction, blunt tools with non-cutting tips mechanically remove all of the diseased, demineralized, and partially disrupted collagen fibers after they have been chemically softened. [2–6] The anti-inflammatory benefits of the enzyme-based materials may result in reduced discomfort during therapy and improved outcomes overall. Hypochlorite-containing agents are also linked to less anesthetic being required because sodium hypochlorite acts on damaged collagen fibrils that are already infected. [3,8] Among these agents are Carisolv (Mediteam, Sweden) for the hypochlorite-based agents, while PapaCarie (F&A Laboratório Farmacêutico, São Paulo, Brazil), is considered one of the enzyme-based materials.

Papacarie is an innovative gel used for atraumatic caries removal, offering an efficient alternative to the traditional methods. This gel is composed mainly of Papain, Chloramine, and Toluidine Blue. It acts by breaking down the collagen molecules and softening carious dentine, facilitating its removal without the need for anesthesia. Studies conveyed papacarie as a safe, natural, and non-toxic option that provides a gentle, efficient, satisfactory and comfortable experience for patients during caries removal procedures. [8-10]

Water, the primary component of enamel and dentin, absorbs Er,Cr:YSGG lasers with an emission wavelength of 2780 nm. Water in the dental tissue absorbs laser photons, raising the temperature above the water evaporation temperature. By increasing the interstitial water pressure, this causes nearby tissues to decompose explosively, eliminating all associated tissue and impurities. [11] The treatment's success is increased by this ablation procedure, which exposes the dentinal tubules with improved adhesion potentials and encourages the clearance of bacteria. [13] Additionally, because infected dentinal tissues have a higher water content, its absorption in water increases its selectivity in removing caries.

Bond strength tests are popular procedures that have been employed to predict the effectiveness of adhesive systems and the clinical behavior of bonded resin composites. The selected testing method should be relatively easy to perform, repeatable within and between laboratories, and useful for predicting clinical outcomes. The micro-shear bond strength test (μSBS) is currently recommended as a reliable method for evaluation of adhesive materials bonding efficacy. Therefore, microshear bond strength testing was selected in this study.

In our current research, the impact of using Er,Cr:YSGG Laser and chemomechanical method (PapaCarie) on the microshear bond strength of resin composite to caries affected dentin was evaluated in comparison to the conventional caries removal.

The results of the current study have shown the highest mean microshear bond strength (25.31 MPa) in Group 1 (PapaCarie group), followed by followed by Group 2 (laser group) with mean value (24.46 MPa), with the lowest value for the Group 3 (conventional group) (23.98 MPa), with no significant difference between all groups, but still considered comparable results. Our results were in agreement with other previous studies reporting that Papacarie could positively impact the bond strength, and its application increases the shear bond strength between resin composite and dentin. [2-8] This was attributed to the fact that PapaCarie treatment leads to certain morphological changes in the residual dentin that favors strong bonding and good marginal sealing. [2-8]

Additionally, PapaCarie has been reported to create minimal smear layer and open dentinal tubules, resulting in longer resin tags and superior bonding characteristics. Overall, it is claimed that the application of PapaCarie on dentin enhances bond strength by making the residual dentin more porous and irregular, leading to improved bonding capacity of the resin and better bond strength values. [23]

The results of Group 2 (Laser group), were also in accordance with other studies affirming that using Er,Cr:YSGG Laser on dentin surfaces increases resin infiltration into dentinal tubules leading to improved bond strength. [11-13] Since the laser treatment opens the dentinal tubules and removes the smear layer, improving resin infiltration and surface characteristics, thus enhancing the adhesion of resin composite to dentin. [24, 25]

The findings of the current study have indicated that the caries removal protocols using different methods, have shown no statistically significant difference on their effect on the bond strength of resin composite to caries affected dentin. So based on the findings of the current study, the null hypothesis was accepted.

It is imperative to highlight that this study assessed the impact of using different caries removal methods on the bond strength of resin composite to caries affected dentin. This is a crucial factor in determining the overall success of the restorative treatment, that may affect the adhesive behavior of the resin material.

Although using PapaCarie and Er,Cr:YSGG Laser could yield to better outcomes, and despite the claims of the potential benefits they could bring, yet still further studies and more evidence are recommended to assess the effectiveness of various methods for increasing the resin-dentin bond strength and look into the potential of varying the Er,Cr:YSGG Laser's parameters for the strongest possible bond.

PapaCarie and Er,Cr:YSGG Laser caries removal protocols are considered to be relatively painless procedures compared to conventional excavation protocols. In addition to the selectivity in caries removal that add to the preservation of the pulp and the vitality of the tooth especially in management of deep caries lesions. [21]

The challenge of gathering recently extracted sound molar teeth with extensive occlusal caries was one of the study's shortcomings. Additionally. The intricate structure of the oral environment is not adequately reflected by this in vitro investigation. Since there was no statistically significant difference in the microshear bond strength of resin composite to caries-affected dentin between the use of the Er,Cr:YSGG Laser and the chemomechanical approach (Papacarie), the null hypothesis of this study was accepted.

CONCLUSIONS

The following conclusions can be drawn from the current study's findings:

1. Papacarie's bond strength to dentin afflicted by caries exhibited encouraging results.
2. However, equivalent and satisfactory results can still be obtained using both the traditional caries removal approach and the Er,Cr:YSGG Laser.

Declarations

Publication consent: Not applicable

Data and material availability: Upon reasonable request, the corresponding author will make the datasets used and/or analyzed in the current study available.

Conflicting interests: According to the writers, they have no conflicting interests.

Funding: Self-funded

Contributions of the authors: "Every author helped with the design and conceptualization of the study. [Inas El Zayat], [Ahmed Tarek Farouk], [Youssef Sedky], and [Mohamed Bahgat Abdelhamid] prepared the materials, collected the data, and conducted the analysis. [Inas El Zayat] wrote the original draft of the book, and all contributors provided feedback on earlier iterations. The final manuscript was read and approved by all writers.

REFERENCES

1. Yazici AR, Atílla P, Ozgünaltay G, Müftüoglu S. In vitro comparison of the efficacy of Carisolv and conventional rotary instrument in caries removal. J Oral Rehabil. 2003;30:1177–82. [PubMed: 14641660]
2. Jawa D, Singh S, Somani R, Jaidka S, Sirkar K, Jaidka R. Comparative evaluation of the efficacy of chemomechanical caries removal agent (Papacarie) and conventional method of caries removal: An in vitro study. J Indian Soc Pedod Prev Dent. 2010;28:73–7. [PubMed: 20660971]
3. Doglas C, Farina AP, Orlando F, Brusko FH, Bruno CJ. Effect of Carisolv and Papacarie on the resin-dentin bond strength in sound and caries-affected primary molars. Braz J Oral Sci. 2010;9:25–9.
4. Haak R, Wicht MJ, Noack MJ. Does chemomechanical caries removal affect dentine adhesion? Eur J Oral Sci. 2000;108:449–55. [PubMed: 11037762]
5. Beeley JA, Yip HK, Stevenson AG. Chemochemical caries removal: A review of the techniques and latest developments. Br Dent J. 2000;188:427–30. [PubMed: 10953400]
6. Banerjee A, Watson TF, Kidd EA. Dentine caries excavation: A review of current clinical techniques. Br Dent J. 2000;188:476–82. [PubMed: 10859846]

7. Arvidsson A, Ortengren U, Wennerberg A. Influence of chemo-mechanical caries removal on the surface topography of dental composite resin and glass-ionomer materials: An in vitro study. Acta Odontol Scand. 2004;62:137–42. [PubMed: 15370632]

8. Bussadori SK, Castro LC, Galvão AC. Papain gel: A new chemo-mechanical caries removal agent. J Clin Pediatr Dent. 2005;30:115–9. [PubMed: 16491964]

9. Silva LR, Motta LJ, Reda SH, Facanha RA, Bussadori SK. Papacarie: A new system for the chemo-mechanical caries removal—case report. Rev Paul Odontol; 16:4-8, 2004.

10. Balciuniene I, Sabalaite R, Juskiene I. Chemo-mechanical caries removal for children. Stomatologija; 7:40- 4, 2005.

11. Jingarwar M.M., Bajwa N.K., Pathak A. Minimal Intervention Dentistry—A New Frontier in Clinical Dentistry. J. Clin. Diagn. Res. 2014;8:ZE04–ZE08. doi: 10.7860/JCDR/2014/9128.4583.

12. Montedori A., Abraha I., Orso M., D'Errico P.G., Pagano S., Lombardo G. Lasers for caries removal in deciduous and permanent teeth. Cochrane Database Syst. Rev. 2016;9:CD010229.

13. Wong Y.J. Caries removal using lasers. Evid. Based Dent. 2018;19:45. doi: 10.1038/sj.ebd.6401303.

14. Tandon S, Silas A. Caridex: Dentin topography and bond strength evaluation. Indian J Dent Res. 1992;3:76– 82. [PubMed: 1343960]

15. Wolski K, Goldman M, Kronman JH, Nathanson D. Dentinal bonding after chemomechanical caries removal - Effect of surface topography. Oper Dent. 1989;14:87–92. [PubMed: 2697863]

16. McInnes-Ledoux P, Ledoux WR, Weinberg R. Bond strength of dentinal bonding agents to chemomechanically prepared dentin. Dent Mater. 1987;3:331–6. [PubMed: 3326778]

17. Bouillaguet S, Troesch S, Wataha JC, Krejci I, Meyer JM, Pashley DH (2003) Microtensile bond strength between adhesive cements and root canal dentin. J Dent Mater 19(3):199–205

18. Dorri M., Martinez-Zapata M.J., Walsh T., Marinho V.C., Sheiham A., Zaror C. Atraumatic restorative treatment versus conventional restorative treatment for managing dental caries. Cochrane Database Syst. Rev. 2017;2017 doi: 10.1002/14651858.CD008072.pub2. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

19. Muntean A., Mesaros A.S., Festila D., Mesaroș M. Modern management of dental decay in children and adolescents—A review. Clujul Med. 2015;88:137–139. doi: 10.15386/cjmed-401.

20. Sugars and Dental Caries. [(accessed on 5 August 2020)]; Available online:https://apps.who.int/iris/bitstream/handle/10665/259413/WHO-NMH-NHD-17.12-eng.pdf?sequence=1

21. Ammari M.M., Moliterno L.F.M., Junior R.H., Séllos M.C., Soviero V.M., Filho W.P.C. Efficacy of chemomechanical caries removal in reducing cariogenic microbiota: A randomized clinical trial. Braz. Oral Res. 2014;28:1–6. doi: 10.1590/1807-3107BOR-2014.vol28.0031.

22. Tanboga I., Eren F., Altınok B., Peker S., Ertugral F. The effect of low level laser therapy on pain during dental tooth-cavity preparation in children. Eur. Arch. Paediatr. Dent. 2011;12:93–95. doi: 10.1007/BF03262786.

23. Chittem J, Sajjan GS, Varma KM. Comparative evaluation of microshear bond strength of the caries-affected dentinal surface treated with conventional method and chemomechanical method (papain). J Conserv Dent. 2015 Sep-Oct;18(5):369-73.

24. Jaberi Ansari Z, Fekrazad R, Feizi S, Younessian F, Kalhori KA, Gutknecht N. The effect of an Er,Cr:YSGG laser on the micro-shear bond strength of composite to the enamel and dentin of human permanent teeth. Lasers Med Sci. 2012 Jul;27(4):761-5.

25. Silva AC, Melo P, Ferreira JC, Oliveira T, Gutknecht N. Adhesion in Dentin Prepared with Er,Cr:YSGG Laser: Systematic Review. Contemp Clin Dent. 2019 Jan-Mar;10(1):129-134.