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Adhesive Bond Strength of Er Cr YSGG Laser Treated Deciduous Dentin to Resin Cements

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ABSTRACT

The present study was performed to assess the adhesive bond strength of Er Cr YSGG laser treated deciduous dentin to resin cements. Forty deciduous teeth were collected and stored in saline solution for 24 hrs. The prepared specimens were divided into two groups, group A (control, n=10) and laser treated groups (B, C, D) (n=30). The control group specimens were treated with 37% phosphoric acid (Rely-X-ARC) while specimens in remaining groups underwent Er Cr YSGG laser treatment. Furthermore, the three laser groups were divided based on the types of the cement build-ups employed; Rely X ARC, Rely X Unicem and GIC. Cement builds up were placed on each specimen using a putty mould followed by light cure in the resin based cements. After storage in distilled water (twenty-four hrs), the prepared specimens were tested for shear bond strength in a universal testing machine. Collected data was analysed using Analysis of variance (ANOVA) and Tukey multiple comparisons test. A significant difference in bond strength between the groups ($p< 0.05$) was observed; however, the control group presented with highest shear bond strength of 25.38 (3.81) MPa among all groups. Specimens treated with laser and bonded to Rely X ARC and Rely X Unicem showed comparable ($p>0.05$) bond strength outcomes. Lased specimens bonded to GIC exhibited significantly lower bond strength compared to other laser treated groups ($p<0.05$). Among all groups the most common type of observed failure was adhesive followed by the admixed and cohesive (GIC-D) respectively. Both surface treatment (laser) and cement type showed significant influence on their bond strength to deciduous dentin

KEY WORDS: ER CR YSGG LASER, DECIDUOUS TEETH, PRIMARY DENTIN, RESIN CEMENTS, BOND STRENGTH.

INTRODUCTION

Paediatric dentistry requires understanding and knowledge of restorative materials and techniques used in deciduous teeth (Koch et al., 2017). Conservative management is key in managing tooth destruction in children (Reston et al., 2011). Nevertheless, it is opted as the first step in the caries management continuum, which is based on the progressive philosophy to eliminate biofilm and demineralisation before tooth reconstruction (Hurlbutt and Young, 2014). Therefore, a proactive therapeutic approach is essential in managing early caries lesion in children (Hurlbutt and Young, 2014). The chronic lesions are followed up by minimally invasive restoration and conventional treatment. Composite resin and GIC are the most commonly used restorative materials in deciduous teeth (Frencken et al., 2012, Tellez et al., 2011). Minimally invasive treatment for management of carious deciduous teeth is the goal. Currently, lasers are gaining more

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attention in abrading the hard tissues of deciduous teeth to increase the retention of the restoration thereby reducing the need for local anaesthesia. Thus, the use of laser reduces time, improves efficiency and is comfortable for the patient (Tellez et al., 2011, Koch et al 2017).

Humans are diphyodonts who have sets of teeth that are unique in nature and characteristics (Neves et al., 2016). Retentive restoration in the primary teeth is essential as these teeth act as spacers and maintains masticatory function in children. Literature states that the primary teeth differ from permanent teeth in enamel and dentin quantity, pulpal anatomy, and tubular density (Lenzi et al., 2014). Studies have shown that the difference in physiological and morphological features influences the adhesive properties of the restorative materials. Presence of low inorganic content in deciduous teeth requires tooth conditioning for longer duration or strong surface acid etchant (de Siqueira Mellara et al., 2014, Sfondrini et al., 2011). However, the use of lasers recently as surface treatment has presented with improved bonding strength in deciduous teeth with resin cements (Neves et al., 2016, Kerkis and Caplan, 2012). Nevertheless, some studies have shown no change in the shear bond strength despite the differences with the permanent teeth (Lenzi et al., 2014, de Siqueira Mellara et al., 2014, Koch et al 2017).

Lasers are conceded as clinically practical and safe in children for preparation of deciduous teeth. Conventional lasers were limited due to their thermal effects on the large pulp chambers in the deciduous teeth; however low-level laser therapy with contemporary lasers has resolved this issue (Ansari et al., 2012). Studies have used lasers with variating wavelengths to accomplish optimum results with low adverse effects such as Er Cr YSGG. The erbium, chromium:yttrium-scandium-gallium-garnet(Er,Cr:YSGG) is a well-developed hydrophotonic pulsed laser system(Shafiei et al., 2013). The laser has the ability to abrade the surface efficiently without the deposition of the smear layer (Shafiei et al., 2013). In animal testing, Er Cr YSGG lasers have proved successful in producing low thermal effects and damage to the pulp, especially when used with water spray (Shahabi et al., 2013). It is hypothesised that the laser transfers the energy through the water droplets, which creates micro expansion to abrade the surface and removes debris (Giray et al., 2014).

Many studies have evaluated bond strength using lasers in comparing permanent and deciduous teeth (Bandéca et al., 2012, Ramos et al., 2014). It is suggested, that both deciduous and permanent dentition show similar shear bond strength outcomes in addition ot the topographical changes in both sets of teeth (Tseng et al., 2007, Giray et al., 2014). Literature suggests successful use of laser to improve bond integrity through an increase in surface resistance and reduced micro leakage (Shahabi et al., 2013).

However, limited data have been collected regarding the adhesive bond strength of resin cements to laser treated surface in deciduous teeth. Therefore, it is hypothesised that laser surface treatment will improve adhesive bonding strength of primary dentin with resin cements. The aim of the present study was to investigate the shear bond strength of Er,Cr:YSGG laser treated deciduous dentin when adhesively bonded to resin cements.

MATERIAL AND METHODS

After the approval from the institutional review board, the study was conducted to evaluate the adhesive bond strength of Er Cr YSGG laser treated deciduous dentin to resin cements. Forty deciduous premolars and molars were submerged in 0.9% saline solution immediately after the extraction and stored for 24 hrs at 25°C. The teeth were embedded into the acrylic teeth containing the polyvinyl chloride tubes with buccal surface exposed. The crown of each specimen was cut by the high-speed hand piece (Midwest Dental Products, Corp, IL) to a 3.5mm x 3.5 mm depth exposing a wide area of dentin. The drilled buccal surface was polished with the slow cutting polishing disc (3M™ ESPE™ Sof-Lex™ Diamond Polishing System, Canada) for 2 mins followed by a saline wash for 5 mins. The prepared specimens were divided into a total of four groups (n=10) with single bonded surface exposed to different surface treatment and cement applications.

Initially, the specimens were divided based on the surface treatment into two groups; control (n=10) and laser treated surface (n=30). The laser used for the surface treatment was Er,Cr:YSGG laser HKS (Waterlase system, BioLaseTechnology, Inc, San Clemente, CA.). The laser was operated at a wavelength of 2.78 mm with a pulse duration of 140µs and a frequency of 20 Hz. Subsequently, the laser treated group was further divided into three groups based on the type of cement build-up. Cement build-ups were performed using three different types of cement; self-etch cement (Rely-X Unicem), Resin cement (Rely-X ARC) and Glass ionomer cement (GIC). A polyvinyl siloxane putty mould (2mm x 3mm) was placed on the specimen to perform build-ups of cement.

The groups are as follows: Group A: 10 specimens in this group acts as control following the conventional surface treatment. All the teeth were etched with 37% phosphoric acid (Ivoclar Vivadent AG, FL-9494 Schaan/ Liechtenstein) for 60 seconds followed by rinse and air dried for one second. The micro brush was used to apply the bonding agent (Prime and bond NT, Dentsply Int. Inc USA) on the etched surface followed by a light cure for 10 seconds. A build-up of Rely-X ARC was performed and light cured for 40 secs from four sides (160 sec).

Group B: The surface of each specimen was laser treated. Rely X Unicem was auto mixed and applied on the bonding surface using a mould. Excess cement was removed and light cured for 40 secs from four sides (160 secs).

Group C: Following laser treatment, each specimen was coated with adhesive bond (Prime and bond NT Dentsply Int. Inc, USA.) light cured for 10 secs and build-up of resin cement (Rely-X ARC) was performed as explained previously.

Group D: The laser treated surface was further treated with polyacrylic acid (Ketac molar, 3M, Germany) for 10 seconds. Glass ionomer cement (GIC) (Ketac Cem Aplicap, 3M, Germany) capsules were auto-mixed and applied to the deciduous teeth surface using a putty mould for build-up. After the setting of GIC, following an hour the mould was removed along with excess cement.

All the specimens were placed in distilled water following the build up for 24 hrs prior to shear bond testing. The shear bond strength was tested using an Instron testing machine (Instron Corp, Canton, MA.) the load applied was perpendicular to the composite build up tooth interface using a knife, at cross-head rate of 0.05 in/min. Interfacial bond failure assessment was performed after the fracturing of specimens using a light microscope. The failures were divided up into three categories adhesive, cohesive and admixed. Failure at the interface of build-up and tooth surface was termed as adhesive whereas fracture internally in the cement was termed as cohesive failure. Moreover, any remains of the cement on the fractured interface surface were defined as admixed failure.

Statistical software for social sciences (SPSS 20.0 version) was employed in the collected data analyses. The normality of data was assessed using Kolmogorov-Smirnov test. Mean and standard deviations (SD) of the observed data were assessed using descriptive statistics. Adhesive Bond strength was analysed using the ANOVA with $p < 0.05$ considered as a level of significance. A comparison of means and SD were performed with ANOVA and Multiple comparisons tests (Tukey-Kramer).

Table 1. Materials and product detail

Material	Product detail
Rely X ARC	3M™ Clicker™ Dispenser, USA.
Rely X unicem	Aplicap™ / Maxicap™ , 3M ESPE, USA.
GIC	(Ketac Cem Aplicap, 3M, Germany)
Poly acrylic acid	(Ketac molar, 3M, Germany)
Er,Cr:YSGG laser HKS	Waterlase system, BioLase Technology, Inc, San Clemente, CA.
37% phosphoric acid etch	Ivoclar Vivadent AG, FL-9494 Schaan/Liechtenstein
Primer-adhesive system	Prime and bond NT, Dentsply Int. Inc USA

RESULTS AND DISCUSSION

Kolmogorov-Smirnov test showed even distribution of the collected input portraying the normality of data. The mean comparison was made between the four groups. Group A acted as a control, while the laser treated groups were categorised based on the type of cement used B (Rely X Unicem), C (Rely X-ARC) and D (GIC). The computed result indicated that the control group displayed the highest mean shear value of 25.38 (±3.81) MPa, compared to the laser treated groups. Nevertheless, the comparison (ANOVA) presented a significant difference between the specimens among the study groups (A, B, C and D) ($p < 0.05$). There was no significant difference between the bond strength fo group B (Rely X Unicem) and C (Rely X ARC) ($p>0.05$). Moreover, the least mean shear bond strength was displayed in specimens of group D (GIC) (5.91±2.33 MPa). Table 1 shows the means and Standard deviations for shear bond strengths among study groups.

Table 2. Means and Standard deviations for shear bond strengths among study groups

Study Group	Mean	SD	p-value!
Group A (Control)	25.38^{A}	3.81	
Group B (ECL-RelyX-Uni)	20.47^{B}	3.11	< 0.05
Group C (ECL-RelyX-A)	21.65B	3.74	
Group D (ECL-GIC)	15.91^{C}	2.33	

Different capital superscript alphabets denote statistical significant difference. (Multiple comparisons test)
! Analysis of variance (ANOVA) Test.

Two way ANOVA and Tukey HSD Post-hoc test revealed that the SBS strength was influenced more by the surface treatment than the type of cement (Table 2). This can be observed evidently while comparing group A (Etch-bond-Rely X- ARC) and Group C (Er Cr YSGG- Rely X-ARC), which uses similar cement for build up while the surface treatments were different. On the contrary, supporting this statement, there was no difference in groups B and C where the cements were different (Rely X Unicem and GIC), while the surface treatment remains the same. Nevertheless, group C showed a significant difference from other groups ($p<0.05$). Furthermore, observing the interfacial bond failure demonstrated that the majority of the bond failures were adhesive followed by admixed and cohesive respectively. Adhesive failure ranged from 80 – 70% in groups B, A and C whereas the admixed failure ranged from 30 – 20% in similar groups. However, group D presented 6 specimens with adhesive failure while 4 underwent cohesive failures. This indicates weak strength of the material. Table 2 presents with type of failures among the study groups.

The current study was based on the hypothesis that laser surface treatment will improve adhesive bond strength of primary dentin with resin cements. The study further compared the outcome of the laser treated deciduous teeth to the conventionally etched control group. Thus, the comparison between the control (Etch and bond) and Er Cr YSGG laser treated primary dentin, presented better adhesive bond strength for control. The mean shear bond strength was highest in the control group compared to the laser treated groups. The type of the cement showed no significant difference as the bond strength between group A and C specimens were different, however there bond strength among group B (Rely X Unicem) and C (Rely X ARC) was comparable. All these outcomes suggest that the hypothesis was accepted. A multitude of explanations can be attributed for the outcomes observed.

Table 3. Type of failures among the study groups

Study Groups	Adhesive (%)	Cohesive (%)	Mixed (%)
Group A (Control)	70	0	30
Group B (ECL-RelyX-Uni)	80	0	20
Group C (ECL-RelyX-A)	70	0	30
Group D (ECL-GIC)	60	40	0

Researchers have identified that ER CR YSGG laser abrades the tooth surface and removes the intertubular dentin. This process creates surface irregularities and recrystallization with no smear layer, thus increases mechanical retention of restoration. Moreover, the literature has identified an evident difference between the chemical and morphological bonding of dentin in permanent and primary teeth (Shafiei et al., 2013, Scaminaci et al., 2013, Lenzi et al., 2012). The authors have stated that the number of dentinal tubules play an important role in the adhesive bonding system (Bandéca et al., 2012, Calvo et al., 2014). It has been observed that the primary dentin contains a high density of dentinal tubules per mm2, which leads to the presence of thick peritubular dentin. In addition, in primary teeth the content of the intertubular dentin is lesser compared to the permanent teeth, this indicates lower probability for a robust dentin bond due to the low amount of mineralised dentin in the primary dentin.

Multiple factors are also responsible for aiding the retention of restorative materials on tooth dentin, such as acid concentration, different types of laser (Er YAG, Er Cr YSGG) and etching time (Kensche et al., 2016). The primary dentin content mostly comprises of organic matrix thus longer etching time is necessary for deep penetration of the etchant and formation of resin tags; nevertheless, this may have a negative impact on the pulp. In addition, the ratio of dentinal tubules opening to intertubular dentin affects the bond strength due to the water content and collagen (Yildiz et al., 2013, Somani et al., 2016). Another barrier for reliable bonding as suggested by authors is the presence of smear layer while using the self-etching primer systems; however, the present study used total etch system that allows deeper penetration of etchant and resin tags compared to the lasers acting on the surface (Scaminaci et al., 2013, Mosharrafian and Sharifi, 2016). Therefore better bond strength was observed in the specimens treated with conventional (Etch-bond) dentin treatment.

The present study further compares three different types of cement (Rely X arc, Rely Unicem and GIC) based on three different bonding mechanisms, total etch, self-adhesive and chemical bonding, respectively. Rely X ARC presented with higher shear bond strength compared to other cement groups in the current study. Furthermore, comparing within the resin cement groups, Rely X ARC presented slightly higher bonding strength (21.65 ±3.74 MPa) than Rely Unicem (20.47 ±3.11 MPa); however, the multiple comparison test results were comparable. Rely X ARC is based on total etch adhesive system, which allows deeper penetration for resin tag formation in acid etched surface compared to laser abraded surface allowing limited bond formation. Authors have explained that self adhesive cement has a slight property of etching and does not require a prior bond application thus it modifies the smear layer before bonding and allows limited penetration of adhesive cement penetration (Kensche et al., 2016). Nevertheless, in the present study the difference in shear bond strength can be only appreciated under two different surface treatments where similar resin cements were employed.

The present study further displayed that GIC showed the lowest shear bond strength. Bonding for glass ionomer cements depends upon the ionic exchange at the interactive surface. The Polyalkenoate chains bind with the apatite crystals thereby displacing the phosphate ions (Calvo et al., 2014). Thus it builds an ion-enriched layer of cement attached to the treated surface. However, the poly-acid application on the tooth surface has a weak etching effect and low inorganic content, which creates a weak bond between the cement and tooth surface. Previous studies have evaluated the tensile bond strength of cements to deciduous tooth surface (Mazaheri et al., 2015, Calvo et al., 2014).

The present study evaluates the shear bond strength, which assesses the adhesive bond using a modified methodology. Rely X Unicem presented with highest adhesive bond failure indicating slightly less adhesive bond strength compared to Rely X ARC, whereas specimens in group A and C displayed comparable results, suggesting that surface treatment did not have a major impact on the failure mode of cement. Studies have displayed that bond strength for GIC is relatively low (3 to 7 MPa to the conditioned tooth surface (Mazaheri et al., 2015, Calvo et al., 2014). Thus, similar results were appreciated in the present study where GIC presented with the lowest adhesive bond failure.

It is pertinent to state that the study follows has certain limitations. Firstly, the findings can only be associated with the conditions and materials used in the present study and should not be applied broadly. In addition, restorations intra-orally undergo exposure to a hostile environment with occlusal loads, acidic erosion and temperature changes. These conditions are absent in this in-vitro study. Ageing and occlusal loads have shown to reduce the durability of adhesive materials and their bonding (Ramos et al., 2014). Therefore, in-vitro studies assessing the influence of Er Cr YSGG laser dentin treatment for bond strength of adhesive cements with long-term ageing are recommended. Scanning electron microscopy for the assessment for surface topography of primary dentin with Er Cr YSGG laser treatment was not performed in the study; therefore, further studies should evaluate the fractured surface using SEM.

CONCLUSION

The study demonstrated that Er Cr YSGG laser treatment of primary dentin showed potential as a surface treatment regime for adhesive bonding to luting cements. Furthermore, comparable bond strength outcomes were observed for laser treated primary dentin when bonded to self-adhesive cement (RelyX Unicem) and resin cements (RelyX ARC). Primary dentin surface treatment displayed major impact on its adhesive bonding strength, in contrast to the type of cement.

REFERENCES

Ansari, Z. J., Fekrazad, R., Feizi, S., Younessian, F., Kalhori, K. A. and Gutknecht, N. (2012). 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 In Medical Science, 27(4):761-5.

Bandéca, M. C., Pinto, S. C. S., Calixto, L. R., Saad, J. R. C., Barros, É. L. D. and Shelb, A. (2012). Influence Of Er, Cr: Ysgg Laser On Bond Strength Of Self-Adhesive Resin Cement. Materials Research, 15(4):491-4.

Calvo, A. F. B., Alves, F. B. T., Lenzi, T. L., Tedesco, T. K., Reis, A., Loguercio, A. D. and Raggio, D. P. (2014). Glass Ionomer Cements Bond Stability In Caries-Affected Primary Dentin. International Journal Of Adhesion And Adhesives, 48:183-7.

De Siqueira Mellara, T., Palma-Dibb, R. G., De Oliveira, H. F., Paula-Silva, F. W. G., Nelson-Filho, P., Da Silva, R. A. B., Da Silva, L. A. B. and De Queiroz, A. M. (2014). The Effect Of Radiation Therapy On The Mechanical And Morphological Properties Of The Enamel And Dentin Of Deciduous Teeth—An In Vitro Study. Radiation Oncology, 9(1):30.

Frencken, J. E., Peters, M. C., Manton, D. J., Leal, S. C., Gordan, V. V. and Eden, E. (2012). Minimal Intervention Dentistry For Managing Dental Caries–A Review: Report Of A Fdi Task Group. International Dental Journal, 62(5):223-43.

Giray, F. E., Duzdar, L., Oksuz, M. and Tanboga, I. (2014). Evaluation Of The Bond Strength Of Resin Cements Used To Lute Ceramics On Laser-Etched Dentin. Photomedicine And Laser Surgery, 32(7):413-21.

Hurlbutt, M. and Young, D. A. (2014). A Best Practices Approach To Caries Management. Journal Of Evidence Based Dental Practice, 14:77-86.

Kensche, A., Dähne, F., Wagenschwanz, C., Richter, G., Viergutz, G. and Hannig, C. (2016). Shear Bond Strength Of Different Types Of Adhesive Systems To Dentin And Enamel Of Deciduous Teeth In Vitro. Clinical Oral Investigations, 20(4):831-40.

Kerkis, I. and Caplan, A. I. (2012). Stem Cells In Dental Pulp Of Deciduous Teeth. Tissue Engineering Part B: Reviews, 18(2):129-38.

Koch, G., Poulsen, S., Espelid, I. and Haubek, D. (2017). Pediatric Dentistry: A Clinical Approach, John Wiley and Sons.

Lenzi, T. L., Braga, M. M. and Raggio, D. P. (2014). Shortening The Etching Time For Etch-And-Rinse Adhesives Increases The Bond Stability To Simulated Caries-Affected Primary Dentin. J Adhes Dent, 16(3):235-41.

Lenzi, T. L., Soares, F. Z. M. and Rocha, R. D. O. (2012). Degradation Of Resin-Dentin Bonds Of Etch-And-Rinse Adhesive System To Primary And Permanent Teeth. Brazilian Oral Research, 26(6):511-5.

Mazaheri, R., Pishevar, L., Shichani, A. V. and Geravandi, S. (2015). Effect Of Different Cavity Conditioners On Microleakage Of Glass Ionomer Cement With A High Viscosity In Primary Teeth. Dental Research Journal, 12(4):337.

Mosharrafian, S. and Sharifi, Z. (2016). Comparison Of Push-Out Bond Strength Of Two Bulk-Fill And One Conventional Composite To Intracanal Dentin In Severely Damaged Primary Anterior Teeth. Journal Of Dentistry (Tehran, Iran), 13(3):207.

Neves, P. A. M., Lima, L. A., Rodrigues, F. C. N., Leitao, T. J. and Ribeiro, C. C. C. (2016). Clinical Effect Of Photodynamic Therapy On Primary Carious Dentin After Partial Caries Removal. Brazilian Oral Research, 30(1).

Ramos, T. M., Ramos-Oliveira, T. M., Moretto, S. G., De Freitas, P. M., Esteves-Oliveira, M. and De Paula Eduardo, C. (2014). Microtensile Bond Strength Analysis Of Adhesive Systems To Er: Yag And Er, Cr: Ysgg Laser-Treated Dentin. Lasers In Medical Science, 29(2):565-73.

Reston, E., Corba, D., Ruschel, K., Tovo, M. and Barbosa, A. (2011). Conservative Approach For Esthetic Treatment Of Enamel Hypoplasia. Operative Dentistry, 36(3):340-3.

Scaminaci, D. R., Iuliano, V., Franchi, L., Ferrari, M. and Giachetti, L. (2013). Adhesion To Primary Dentin: Microshear Bond Strength And Scanning Electron Microscopic Observation. American Journal Of

Dentistry, 26(6):341-6.
Sfondrini, M. F., Scribante, A., Cacciafesta, V. and Gandini, P. (2011). Shear Bond Strength Of Deciduous And Permanent Bovine Enamel. J Adhes Dent, 13(3):227-30.
Shafiei, F., Fekrazad, R., Kiomarsi, N. and Shafiei, E. (2013). Bond Strength Of Two Resin Cements To Dentin After Disinfection Pretreatment: Effects Of Er, Cr: Ysgg Laser Compared With Chemical Antibacterial Agent. Photomedicine And Laser Surgery, 31(5):206-11
Shahabi, S., Chiniforush, N., Bahramian, H., Monzavi, A., Baghalian, A. and Kharazifard, M. J. (2013). The Effect Of Erbium Family Laser On Tensile Bond Strength Of Composite To Dentin In Comparison With Conventional Method. Lasers In Medical Science, 28(1):139-42
Somani, R., Jaidka, S., Singh, D. J. and Sibal, G. K. (2016). Comparative Evaluation Of Shear Bond Strength Of Various Glass Ionomer Cements To Dentin Of Primary Teeth: An In Vitro Study. International Journal Of Clinical Pediatric Dentistry, 9(3):192.
Tellez, M., Gray, S. L., Gray, S., Lim, S. and Ismail, A. I. (2011). Sealants And Dental Caries: Dentists' Perspectives On Evidence-Based Recommendations. The Journal Of The American Dental Association, 142(9):1033-40.
Tseng, W.-Y., Chen, M.-H., Lu, H.-H., Lin, C.-W., Hsieh, T.-T., Chen, C.-H., Lai, J.-Y. and Lee, B.-S. (2007). Tensile Bond Strength Of Er, Cr: Ysgg Laser-Irradiated Human Dentin To Composite Inlays With Two Resin Cements. Dental Materials Journal, 26(5):746-55.
Yildiz, E., Sirinkaraarslan, E., Yegin, Z., Cebe, M. and Tosun, G. (2013). Effect Of Caries Removal Techniques On The Bond Strength Of Adhesives To Caries-Affected Primary Dentin In Vitro. European Journal Of Paediatric Dentistry: Official Journal Of European Academy Of Paediatric Dentistry, 14(3):209-14.