Received: 10 January 2022 | Revised: 03 March 2022 | Accepted: 07 March 2022
DOI: 10.22034/ecc.2022.329154.1324

Eurasian Chemical Communications SAMI

FULL PAPER

Comparison of tetric N-bond micro-tensile bond strength with QTH and LED light-curing units

Ali Dehghan Dehnavi[a] |Vahid Alizadeh[b] |Elahe Salarpour[c,*]

[a]*Doctor of Dental Surgery, Faculty of Dentistry, Zahedan University of Medical Science, Zahedan, Iran*

[b]*Assistant Professor, Department of Operative, Faculty of Dentistry, Zahedan University of Medical Science, Zahedan, Iran*

[c]*Postgraduate Student, Department of Orthodontics, Faculty of Dentistry, Shahid Sadoughi University of Medical Sciences, Yazd, Iran*

***Corresponding Author:**
Elahe Salarpour
Email: dr.elahe.salarpour@gmail.com
Tel.: N/A

The objective of this study was to examine the effects of two types of light-curing units, namely, QTH and LED on the micro-tensile strength (MTBS) of Tetric N-Bond (combined primer and bonding agent). A total of 20 extracted sound human first premolars were separated into two groups, each of which comprising ten specimens. The surface enamel of specimens for each group was removed by means of a cylindrical diamond bur (TIZKAVAN, IRAN) until dentin was exposed. Next, gelatin capsules, composed of Tetric N-Ceram composite paste, were vertically bonded to the dentin in samples of both groups by means of a light-cure adhesive; however, the curing process in Group 1 was performed using LED and in Group 2 by a QTH device. Crowns of all specimens were divided into vertical slabs of approximately 1 mm thickness in an Occluso-gingival way. Slabs were prepared into hourglass shapes with a width and thickness of 1 mm and 0.8 mm in each group. Micro-tensile bond strength was discovered utilizing a testing machine (Instron-Universal testing machine-Germany.) It was found that LED-cured specimens had a higher micro-tensile bond strength with a significant difference from the QTH-cured ones ($p < 0.05$). The light devices have an impact on the micro tensile bond strength of resin adhesives.

KEYWORDS

Tetric N-bond; micro-tensile bond; curing lights.

Introduction

Today, as people seem to be more aware of dentistry, along with the increasing demand for esthetic qualities, the application of tooth-colored materials has seen a significant rise [1]. Owing to their beauty and conservative features, light-cured composite resins are regarded as restorative materials with wide uses in teeth anterior and posterior restoration [2,3]. Composite resins are of many different generations. The material employed in this study is Tetric n-bond, which is the fifth generation of composite resins. This material is also called dentin binders or single-component dentin binders [4]. In this particular generation, the priming and bonding phases are combined into one step, while the etching is still separate [4]. These adhesive resins are chiefly of a light-curing kind and include Camphor quinone (CQ System) in the form of a photo initiator. CQ system absorbs visible light ranging from 380 to 500 nm with a maximum absorption rate of roughly 470 nm [5].

Quartz-Tungsten-Halogen units (QTH) are among the most prevalent light-curing units utilized to polymerize adhesive resins [6]. Halogen lights have long been the yardstick in dentistry. However, it should be noted that QTH units have their own disadvantages such as limited depth of cure, long exposure time, and low light intensity over time, all of which were the reasons for the development of light-emitting-diode (LED) curing units. The advantages of LED include its power- and spectra-related constant output, longevity, durability, and high energy efficiency. It appears that various light-curing units have distinct impacts on the bonding strength of resin adhesives [7-9].

The quality of adhesion to dental tissues can be evaluated in various ways [10]. The laboratory criteria often preferred for examination of adhesion to dentin are shear bond strength. In this system, a variety of shear forces is utilized between the resin-dentin interfaces [11-13]. Then, the components are normally evaluated to discover the nature of the failure[4]. Nonetheless, the principal problem of this test is that it fails to take account of the three-dimensional geometry of the object under evaluation. Furthermore, these tests do not discover the exact shear and horizontal stress [14-16]. A new method to evaluate the strength of bonds was founded in 1994 [17]. Sano et al proposed a micro-tensile bond strength (MTBS) method which not only measured the bond strength but also determined the interfacial bond strength to very small and irregular surfaces. Additionally, it minimized the number of teeth required for bond strength evaluation. The MTBS method can provide four to five slabs from each tooth[10]. Nakabayashy et al. (1996) maintained that the techniques utilized for determining tensile bond strength of dumbbell-shaped specimens could also be used to show the drawbacks of the adhesive-dentine interface [18-20]. Yet, in another study published in 1999, Pashley and Carvalho made some modifications to the MTBS testing method, thus giving the researchers the chance of selecting a method that would best meet their requirements [21]. They came to the conclusion that thanks to the flexibility and the ability of MTBS to measure regional bond strengths, this method was the best alternative for determining the long-term durability and present adaptability of resin-hard tissue since conventional techniques fail to measure such qualities [22-24]. This study was conducted to compare the micro-tensile bond strength of Tetric n-bond using QTH and LED light-curing units [25].

Materials and methods

The study included a total of 20 extracted sound human maxillary premolars related to orthodontic problems. Upon extraction, the specimens were divided into two equal 10-sample groups through a simple random sampling method. After the teeth were cleansed by hypochlorite solution for 15 seconds, they were then stored in normal saline at 4^0c for two to four months before they were tested. Also, in order to expose dentin, we cut the occlusal surface horizontally by means of a cylindrical diamond bur (Tizkavan, Iran) in a high-speed handpiece (NSK, Japan). After a total of five specimens were prepared, the used bur was thrown away and replaced with a new one. The procedure was carried out by a single operator from the beginning to the end. The surface of dentin was etched with 37% phosphoric acid for 20 seconds. Additionally, two layers of Tetric n-bond (Ivoclar-Vivadent, China) were employed to coat the occlusal etched surface in a row, and the surface was then exposed to air pressure for five seconds. The bonding agent for the first group was cured using the QTH unit (Dentsply, Germany), whereas that of the second group was cured through an LED unit. As required by the manufacturer's instructions, the time needed for the exposure of QTH and LED units were 40 and 20 seconds, respectively. Apart from the inbuilt meters in the curing unit, the curing radiometer was utilized to assess the light intensity prior to every application. Gelatin capsules, each 3.2 mm and 5 mm in diameter and height, respectively, were filled with Tetric n-bond composite (Light-activated paste, Ivoclar Vivadent, China). Later, they were bonded to the etched dentin by Tetric n-bond adhesives, cured by light sources for 40 seconds as stated previously. Moreover, all teeth specimens underwent thermocycling for a thousand 60-second cycles at 5^{0}c (+/-10) 15 second dwell time at various temperatures.

The roots of specimen teeth were severed and their capsule-bonded crowns were individually placed in the proper direction within the special mold of the cutting machine (Vafaei factory/ Iran). To prepare a one mm slab from each tooth, the cuts were made in the occluso-gingival direction. These slabs, in turn, were meticulously cut into an hourglass form with the aim of creating a small bonded area with a width and thickness of 1 mm and 0.8 mm, respectively, positioned at the bonded surface through a superfine diamond bur (TIZKAVAN, Iran) in an air rotor handpiece (NSK, Japan) with water. An overall number of ten slabs were created for each group. It should be noted that, prior to testing, the thickness and width of each specimen were assessed by digital calipers (Adoric 06", China) to compute the bonded surface area. The micro-tensile bond strength test was performed similarly to that of Sano's method (Table 1).

The hourglass trimmed slabs were fixed onto a micro-tensile testing machine (Instron-Universal testing machine-Germany). It should be noted that the micro-tensile bond strength was calculated at a 0.5mm/min crosshead speed while the specimens were placed under stress to fail. Statistical analysis of the data for the micro-tensile bond strength was conducted through student t-tests at significance level of 0.05.

Results and discussion

The results are as follows:

TABLE 1 Distribution of data and mean, standard deviation, minimum and maximum values of micro-tensile bond strength of tetric N-bond in group I

	Micro-tensile bond strength		
	QTH		LED
Number	10		10
Kolmogorov-Smirnov Z	0.686		0.404
P Value	0.734		0.979
Number	Minimum	Maximum	deviation Mean Standard
10	3.93	7.57	1.17189

As the significance level obtained from Kolmogorov-Smirnov tests for tensile bond strength was higher than 0.05 in both types of devices, it showed that the data were normally distributed [26-28]. Accordingly, parametric tests were employed to investigate the objectives of the research. Also, it suggests that the mean value for the micro-tensile bond strength in LED group is 5.82, ranging from a minimum of 3.93 to a maximum of 7.57 (Figure 1).

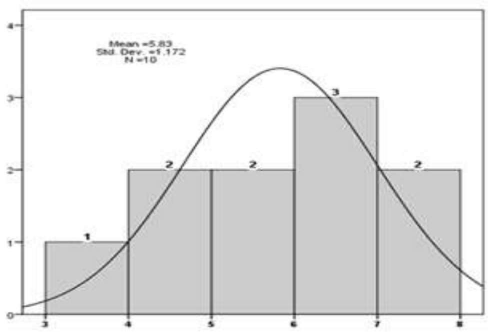

FIGURE 1 Micro-tensile bond strength

TABLE 2 The mean, standard deviation, minimum, maximum values of micro-tensile bond strength of tetric N-bond cured by QTH device and T-test to compare micro-tensile bond strength of tetric N-bond in group I and II

		Number	Minimum	Maximum	Mean	Standard deviation
Micro-tensile bond strength		10	1.46	1.96	1.7750	18253
	Value	Degrees of freedom	P. value	mean difference	low limit	High limit
Micro-tensile bond strength	10.804	18	0.05	4.05200	3.26404	4.83966

As the table above shows, the mean micro-tensile bond strength in the QTH device is 1.77, ranging from a minimum of 1.46 to a maximum of 1.96. As shown in Table 2, the difference between the mean micro-tensile bond strength for two research group is 4.05, which is statistically significant as suggested by t-test. In other words, micro-tensile bond strength in LED group (I) is clinically significant compared with that of QTH group (II) (Figure 3).

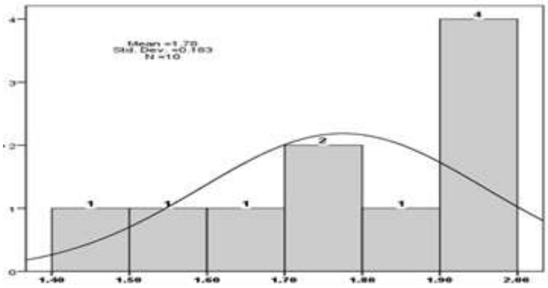

FIGURE 2 Micro-tensile bond strength

95% confidence level for the average

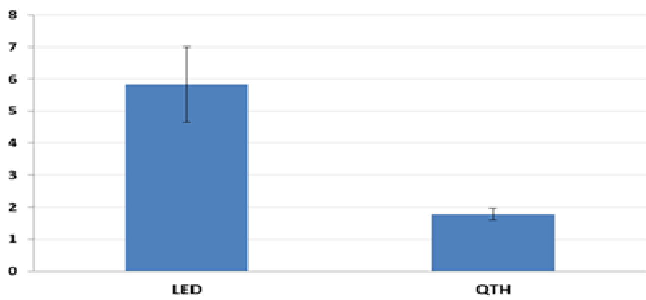

FIGURE 3 Comparison of the micro-tensile bond strength of tetric N-bond cured by LED and QTH units

Discussion

This study was conducted to evaluate the efficiency of polymerization performed using QTH and LED regarding the micro tensile bond strength (MTBs) [29-31]. It was found that light sources affected the bond strength, thereby the null hypothesis was rejected. Most of the studies conducted on composite resins employed usually the same the restorative material and the bonding agent [32]. Physical and mechanical characteristics of resin adhesives, which are polymerized by various light sources, are likely to be affected by these units [16]. In this study, the micro tensile bond strength (MTBs) test was measured by means of hourglass-shaped specimen. The MTBs has had wide applications as an adhesive property. An enormous number of studies have shown that the light-curing units influence the resin bonding adhesive-dentin bond strength, which is considered a contradictory finding [33].

Another study evaluated the effectiveness of a LED light curing unit (LCU) in comparison to that of a QTH (LCU) in terms of different composite conversions. It was shown that LED (LCU) affected composite conversions more significantly than QTH (LCU) in all the groups in the study [34]. Likewise, QTH light source (DENTSPLY) was reported to have the lowest mean bond strength in the present study, which is likely to be due to several factors. Firstly, given that QTH light sources have a separate filter system, a small part of the energy generated by these light sources is converted to blue light. Secondly, QTH units have an intensity of 500 mw/cm^{2}, which is lower than that of LED devices employed in this study[20]. In another study, Camilton (2008) assessed the impact of various light-curing units, yielding best statistical results when the composite was polymerized with LED light source, whereas clinically no difference was observed between the two groups[21]. In 2014, a study conducted on comparative evaluation of the effect of light intensities and curing cycles of QTH, and LED lights on micro-leakage of Class-V composite resins. The study revealed a minimum amount of micro-leakage in LED soft start mode [35].

In another study, four different composites were subject to QTH, LED and PAC light-curing sources for polymerization [36]. Contrary to our result, no difference was observed in bond strength with dissimilar light units. Another study examined the effect of light sources on bond strength of different bulk composites. It was found that the light devices affect the bond strength, and that the LED units have better results than QTH in all groups.

Conclusion

In our study, failed adhesion was most common in the group exposed to the halogen light sources. In other words, LED group had better micro tensile bond strength which can be attributed to the performance of LED lights in comparison to that of contemporary QTH lights. While all the limitations of this study were taken into account, it was found that the light devices had an impact on the micro tensile bond strength of resin adhesives. Additionally, the conclusion of any study as to the superior performance of LED units should be interpreted cautiously as the results are only valid for the particular resin adhesive employed in this study.

Acknowledgements

We would like to thank all the people who helped in preparing and compiling the article and collecting the available data.

Orcid:

Ali Dehghan Dehnavi: https://orcid.org/0000-0003-3708-3201

Elahe Salarpour: https://orcid.org/0000-0001-5667-810x

References

[1] A. Firoozfar, M. Dousti, *Magazine of Civil Engineering*, **2019**. *90*, 119-129. [Crossref], [Google Scholar], [Publisher]

[2] A. Sharma, S. Tiwari, M.K. Deb, J.L. Marty, *Int. J. Antimicrob.*, **2020**, *56*, 106054. [Crossref], [Google Scholar], [Publisher]

[3] A. Susanabadi, S. Etemadi, M.S. Sadri, B. Mahmoodiyeh, H. Taleby, M. Milani Fard, *Ann. Romanian Soc. Cell Biol.*, **2021**, *25*, 2875-2887. [Google Scholar], [Publisher]

[4] A. Zali, M.R. Sohrabi, A. Mahdavi, N. Khalili, M.S. Taheri, A. Maher, M. Sadoughi, A. Zarghi,

S.A. Ziai, A.A. Shabestari, M. Bakhshayeshkaram, *Acad. Radiol.*, **2020**, *28*, 1654-1661. [Crossref], [Google Scholar], [Publisher]

[5]A. Milani Fard, M. Milani Fard, *Eurasian J. Sci. Technol.*, **2022**, *2*, 14-31. [Crossref], [Google Scholar], [Publisher]

[6] C.C. Lai, T.P. Shih, W.C. Ko, H.J. Tang, P.R. Hsueh, *Int. J. Antimicrob.*, **2020**, *55*, 105924. [Crossref], [Google Scholar], [Publisher]

[7] C.R. Jutzeler, L. Bourguignon, C.V. Weis, B. Tong, C. Wong, B. Rieck, H. Pargger, S. Tschudin-Sutter, A. Egli, K. Borgwardt, M. Walter, *Travel Med. Infect. Dis.*, **2020**, *37*, 101825. [Crossref], [Google Scholar], [Publisher]

[8] Z. Cheng, Y. Lu, Q. Cao, L. Qin, Z. Pan, F. Yan, W. Yang, *Am. J. Roentgenol.*, **2020**, *215*, 121-126. [Crossref], [Google Scholar], [Publisher]

[9] F. Fu, J. Lou, D. Xi, Y. Bai, G. Ma, B. Zhao, D. Liu, G. Bao, Z. Lei, M. Wang, *Eur. Radiol.*, **2020**, *30*, 5489-5498. [Crossref], [Google Scholar], [Publisher]

[10] F. Shi, J. Wang, J. Shi, Z. Wu, Q. Wang, Z. Tang, K. He, Y. Shi, D. Shen, *IEEE Rev. Biomed. Eng.*, **2020**, *14*, 4-15. [Crossref], [Google Scholar], [Publisher]

[11] F.E. Sadr, Z. Abadi, N.E. Sadr, M. Milani Fard, *Ann. Romanian Soc. Cell Biol.*, **2021**, *25*, 6839-6852. [Google Scholar], [Publisher]

[12] B.K.K. Fields, N.L. Demirjian, H. Dadgar, A. Gholamrezanezhad, *Semin. Nucl. Med.*, **2020**, *51*, 312-320. [Crossref], [Google Scholar], [Publisher]

[13] J. Liu, H. Yu, S. Zhang, *Eur. J. Nucl. Med. Mol. Imaging.*, **2020**, *47*, 1638-1639. [Crossref], [Google Scholar], [Publisher]

[14] K. Ghajarzadeh, M.M. Fard, H. Alizadeh Otaghvar, S.H.R. Faiz, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M.M. Fard, M.R. Alebouyeh, *Ann. Romanian Soc. Cell Biol.*, **2021**, *25*, 2457-2465. [Google Scholar], [Publisher]

[15] K. Ghajarzadeh, M. Milani Fard, M.R. Alebouyeh, H. Alizadeh Otaghvar, A. Dabbagh, M. Mohseni, S.S. Kashani, A.M. Milani Fard, S.H.R. Faiz, *Ann. Romanian Soc. Cell Biol.*, **2021**, *25*, 2466-2484. [Google Scholar], [Publisher]

[16] M. Carotti, F. Salaffi, P. Sarzi-Puttini, A. Agostini, A. Borgheresi, D. Minorati, M. Galli, D. Marotto, A. Giovagnoni, *Radiol. Med.*, **2020**, *125*, 636-646. [Crossref], [Google Scholar], [Publisher]

[17] M. Dousti, A. Firoozfar, *J. Eng. Ind. Res.*, **2022**, *3*, 54-68. [Crossref], [Google Scholar], [Publisher]

[18] M.B. Abhari, P.F. Afshar, R. Alimoradzadeh, H. Mirmiranpour, *Immunopathol. Persa*, **2019**, *6*, e10. [Crossref], [Google Scholar], [Publisher]

[19] R. Alimoradzadeh, H. Mirmiranpour, P. Hashemi, S. Pezeshki, S.S. Salehi, *J. Neurology Neurophys.*, **2019**, *10*, 1-5. [Google Scholar], [Publisher]

[20] R. Alimoradzadeh, M. Mokhtare, S. Agah, *Iran. J. Age.*, **2017**, *12*, 78-89. [Crossref], [Google Scholar], [Publisher]

[21] R. Alimoradzadeh, M.A. Abbasi, F. Zabihi, H. Mirmiranpour, *Iran. J. Ageing*, **2021**, *15*, 524-533. [Crossref], [Google Scholar], [Publisher]

[22] S. Etemadi, B. Mahmoodiyeh, S. Rajabi, A. Kamali, M.M. fard, *Ann. Romanian Soc. Cell Biol.*, **2021**, *25*, 2417. [Google Scholar], [Publisher]

[23] S. Ghorbanizadeh, Y. Raziani, M. Amraei, M. Heydarian, **2021**, *12*, 54-58. [Crossref], [Google Scholar], [Publisher]

[24] S. Saedi, A. Saedi, M.M. Ghaemi, M. Milani Fard, *Eurasian J. Sci. Technol.*, **2022**, *2*, 233-241. [Crossref], [Google Scholar], [Publisher]

[25] S. Saedi, A. Saedi, M.M. Ghaemi, M. Milani Fard, *Eurasian J. Sci. Technol.*, **2021**, *2*, 180-196. [Crossref], [Google Scholar], [Publisher]

[26] S.M. Hashemi, M. Hashemi, G. Bahari, A. Khaledi, H. Danesh, A. Allahyari, *Asian Pac. J. Cancer Prev. APJCP*, **2020**, *21*, 2479-2484. [Crossref], [Google Scholar], [Publisher]

[27] A. Tahamtan, A. Ardebili, *Expert Rev. Mol. Diagn.*, **2020**, *20*, 453-454. [Crossref], [Google Scholar], [Publisher]

[28] B.

Nazari, L. Amani, L. Ghaderi, M. Khanbabayi gol, *E Trauma Monthly,* **2020**, *25*, 262-268. [Crossref], [Google Scholar], [Publisher]
[29] K. Hashemzadeh, M. Dehdilani, M.K. Gol, *Int. J. Women's Health Reprod. Sci.,* **2021**, *9*, 69-74. [Crossref], [Google Scholar], [Publisher]
[30] K. Hashemzadeh, M. Dehdilani, M. Khanbabayi gol, *Int. J. Women's Health Reprod. Sci.*, **2020**, *8*, 406-411. [Google Scholar], [Publisher]
[31] N. Shahidi, F. Mahdavi, M.K. Gol, *J. Educ. Health Promot.*, **2020**, *9*, 153. [Crossref], [Google Scholar], [Publisher]
[32] R. Eghdam-Zamiri, M. Khanbabayi Gol, *Iran. J. Obstet. Gynecol. Infertil.,* **2020**, *22*, 15-21. [Crossref], [Google Scholar], [Publisher]
[33] V. Poortahmasebi, M. Zandi, S. Soltani, S.M. Jazayeri, *Adv. J. Emerg. Med.*, **2020**, *4*, e57. [Google Scholar], [Publisher]
[34] Y. Raziani, BS. Othman BS., S. Raziani, *Ann. Med. Surg.,* **2021**, *69*, 102739. [Crossref], [Google Scholar], [Publisher]
[35] Y. Raziani, BS. Othman, *Veins Lymphatics,* **2021**, *10*, 5-10. [Google Scholar], [Publisher]
[36] Y. Raziani, S. Raziani, *J. Chem. Rev.,* **2021**, *3*, 83-96. [Crossref], [Google Scholar], [Publisher]

How to cite this article: Ali Dehghan Dehnavi, Vahid Alizadeh, Elahe Salarpour*. Comparison of tetric N-bond micro-tensile bond strength with QTH and LED light-curing units. *Eurasian Chemical Communications*, 2022, 4(6), 456-462. **Link:** http://www.echemcom.com/article_146599.html