ความแข็งแรงของพันธะแบบดึงระดับจุลภาคของเรซินซีเมนต์สองชนิด ณ เวลาแตกต่างกัน

Microtensile Bond Strength of two Resin Cements in Different time Frames

วิโรจน์ วันสม[1*] ชมภูนุช ธรรมเภตรารักษ์[2] ดุสิต เปี่ยมวัฒนาทรัพย์[2] ภัคธีมา เสนคำสอน[2]
พีระยง ธีระกาญจน์[2] พชร พรหมช่วย[2] เสาวลักษณ์ ตรีสงฆ์[2] สุชัญญา มหาทรัพย์ดำรง[8] ธนัชชา คูกีรติรัตน์[2]
ธนพร สุขพิเนตกุล[2] และ ธนัชญาพร สัจจมงคล[2]

Wiroj Wansom[1*] Chompoonut Thampaetrarak[2] Dusit Piamwattanasap[2] Paktheema Senkamsorn[2] Peerayong Theerakarn[2] Phachara Promchouy[2] Saowaluck Treesong[2]
Suchanya Mahasubdumrong[2] Tanatcha KukiIratirat[2] Thanaporn Sukpinatkun[2] and
Thanutchayaporn Sajjamongkol[2]

[1] อาจารย์ประจำ หลักสูตรทันตแพทยศาสตร์บัณฑิต คณะทันตแพทยศาสตร์ มหาวิทยาลัยรังสิต*
ถนนพหลโยธิน ตำบลหลักหก อำเภอเมืองจังหวัดปทุมธานี ประเทศไทย 12000
[2] นักศึกษาหลักสูตรทันตแพทยศาสตร์บัณฑิต คณะทันตแพทยศาสตร์ มหาวิทยาลัยรังสิต
ถนนพหลโยธิน ตำบลหลักหก อำเภอเมืองจังหวัดปทุมธานี ประเทศไทย 12000
[1] Lecturer in Doctor of Dental Surgery, Faculty of Dental Medicine, Rangsit University,*
Phahonyothin Rd., Lak-hok, Patumtanee, Thailand 12000
[2] Dental students, Faculty of Dental Medicine, Rangsit University, Phahonyothin Rd., Lak-hok, Patumtanee, Thailand 12000
**Corresponding author, Email: wiroj.w@rsu.ac.th*

บทคัดย่อ

วัตถุประสงค์เพื่อศึกษาค่าความแข็งแรงของพันธะแบบดึงระดับจุลภาคของเรซินซีเมนต์สองชนิด คือ Superbond C&B และPanavia F2.0 ที่เวลา 1 วัน และ 1 สัปดาห์หลังจากใช้งาน ทดลองโดยการยึดก้อนเรซินคอมโพสิตด้วยเรซินซีเมนต์ก่อนทำการตัดให้ได้ชิ้นทดสอบขนาด 1.5×1.5×8 ลูกบาศก์มิลลิเมตรจำนวน 120 ชิ้น (n=30) โดยแบ่งเป็น 2 กลุ่มย่อยตามชนิดของเรซินซีเมนต์ และในแต่ละกลุ่มของเรซินซีเมนต์เป็นจำนวน 2 กลุ่มเวลาได้แก่ 1 วัน และ 1 สัปดาห์ ชิ้นทดสอบจะถูกเก็บแห้งไว้ในตู้อบอุณหภูมิ 24 องศาเซลเซียส จนถึงเวลาทดสอบ จากนั้นนำวัสดุไปทดสอบหาค่าความแข็งแรงฯโดยเครื่องทดสอบวัสดุเอนกประสงค์ ด้วยความเร็วหัวทดสอบ 1 มม/นาที จนกระทั่งชิ้นทดสอบแตก นำค่าแรงที่ทำให้ชิ้นตัวอย่างแตกมาหารด้วยพื้นที่หน้าตัดของชิ้นตัวอย่างได้เป็นค่าความแข็งแรงพันธะแบบดึงระดับจุลภาค นำไปวิเคราะห์ค่าทางสถิติโดยใช้ Two-way ANOVA และ Tukey's Post Hoc Test พบค่าเฉลี่ยความแข็งแรงฯระหว่างกลุ่ม Superbond C&B สูงกว่า Panavia F2.0 และ ที่เวลา 1 สัปดาห์ ค่าความแข็งแรงฯของเรซินซีเมนต์ทั้ง 2 ชนิด มีค่ามากกว่าเมื่อทดสอบที่ 1 วัน (p<0.05) จึงสรุปได้ว่า Superbond C&B เรซินซีเมนต์มีค่าความ

แข็งแรงของพันธะแบบดึงระดับจุลภาคมากกว่า Panavia F 2.0 ทั้งสองเวลาของการทดสอบ (p<0.05) ไม่พบผลกระทบซึ่งกันและกัน ของปัจจัยทั้งสองต่อค่าความแข็งแรงฯ (p > 0.05) ข้อมูลที่ได้ช่วยในการเลือกใช้วัสดุยึด และการให้คำแนะนำแก่ผู้ป่วย

คำสำคัญ: *ความแข็งแรงของพันธะแบบดึงระดับจุลภาค เรซินซีเมนต์ ช่วงเวลา*

Abstract

The aim of this study was to compare the microtensile bond strength of two resin cements, Superbond C&B and Panavia F2.0 at 1 day and 1 week after application. **A** total of 120 specimens were divided into 2 groups according to the types of resin cements used and further divided into 2 subgroups according to the testing times (1 day and 1 week). Superbond C&B and Panavia F2.0 were used according to the manufacturer's instruction to attach the composite blocks. The attached blocks were cut into a size of 1.5 x 1.5 x 8 mm. Specimens were stored dry in the incubator at 24 degree Celsius until the testing time. All specimens underwent microtensile bond strength testing (μTBS) by a universal testing machine at a cross-head speed of 1 mm/minute until they failed in tension then the μTBS were calculated and statistically tested (α = .05). The two-way ANOVA and Tukey's Post Hoc test demonstrated that the means μTBS of Superbond C&B and Panavia F2.0 showed significant differences for different time frames (p<.05). The means μTBS of both cements at 1 week was more than 1 day (p<.05). There was a non-significant interaction between the resin cements and the time frames, on the μTBS (p>.05). The results helped choose the right cement and yielded informative postoperative care for a patient.

Keywords: *Microtensile bond strength, Resin cements, Time frames*

---

1. Introduction

Resin cements are useful in certain situations such as compromised abutment height or as retainers of fixed partial dentures (FPDs) that have to withstand excessive forces e.g. survey crown because they enhance retention of the restorations (El-Mowafy, 2001; El-Mowafy et al., 1996). Dual-cured resin cements yield better control during the cementation procedure while in deep areas where the curing light cannot penetrate, the self-curing mechanism hardens the cement. However, a number of studies have indicated that self-curing mechanism of some dual-cured cements is inadequate (Darr and Jacobsen, 1995; El-Badrawy, 1995).

Superbond C&B (Sun Medical®, Shiga, Japan), the etch and rinse system with self-cured mechanism, was first launched in 1982 (Minami and Tanaka, 2013). Panavia F2.0 (Kuraray Medical Inc., Osaka, Japan), two-step, self-etching, dual or self-cured resin was launched in 1983. For over three decades, the popularity of both resin cements never ceased and undisputedly known for high bond strength to various substrates; for example, dentin, ceramic and zirconia (Kitayama et al., 2009). Several studies have demonstrated that upon the completion of polymerization cohesive failure occurs more frequently than adhesive failure because of the high bond strength to substrates (Chang et al., 2013; Salazar et al., 2013; Yanga et al., 2006). According to manufacturer's recommendation, the setting time of Superbond C&B and Panavia F2.0 are 6 minutes and 10 minutes, respectively. However, it is still not clear whether the duration of autopolymerizing time after the application will affect the microtensile bond strengths of these cements.

In the present study, we sought to find out if the setting time recommended by the company results in a complete polymerization.

2. Objective

To compare Microtensile bond strength of two resin cements, Superbond C&B and Panavia F2.0 at 1day and 1 week after application.

3. Materials and Methods

3.1 Composite resin block preparation

The composite resin blocks (Filtek™ Z350XT Universal restorative, 3M ESPE, USA) were prepared by incremental technique within the silicone 30 mm x 30 mm x 4 mm molds. They were cured by light curing unit (Demi Plus, Kerr Corporation, Middleton, WI, USA) with wavelength of 450 nm to 470 nm for 40 seconds in each layer. Then the blocks were ground with 100, 400 and 600 SiC (sand paper) for 10 minutes with a polishing machine (RotoPol-21, Struers, Copenhagen, Denmark) under running water. They were subsequently cleaned in an ultrasonic machine (Crest ultrasonic cleaners Penang, Malaysia) for 5 minutes in distilled water then air-dried. The resin blocks were etched for 1 minute with 37% phosphoric acid to decontaminate then washed thoroughly under running water for 1 minute. They were air-dried prior to applying Monobond-S (Vivadent, Liechtenstein) for 1 minute. After air-drying, a thin layer of adhesive agent (Optibond FL; Kerr, Romulus MI, USA) was applied and light-cured for 20 seconds with light curing unit. The aforementioned surface treating procedures were to ensure the integrity of interfacial adhesion between the resin cement and the composite block as this study focused on the strength of the cements themselves. The use of resin cement to attach the composite blocks were to eliminate the possibility that differences in substrate adhesion on each side might play a role in failure, to ease fabrication of the specimens due to brittleness nature as well as inherent cohesive failure of the cement, and to simulate application-relevant situation as thin layer of cement was normally use to attach substrates rather than using it in bulk.

3.2 Microtensile bar specimen preparation

Two celluloid strips of approximately 100 micrometers were placed at the terminal ends of resin composite block in order to provide equal space for the resin cements. Superbond C&B (Sun Medical, Shiga, Japan) and Panavia F2.0 (PA, Kuraray Co. Ltd., Tokyo, Japan) were mixed and applied according to the manufacturer's instruction onto the bonding surfaces. Then the blocks were joined together and a load cell of 1 kilogram was placed on top until they reached their setting time (Setting time of Superbond C&B is 6 minutes and Panavia F2.0 is 10 minutes).

Each joined composite block was sectioned by a low speed cutting saw into rectangular shape of 1.5 mm x 1.5 mm x 8 mm in size. The bars where celluloid strips were placed were discarded. The thickness was measured by a caliper and recorded for further calculation of the cross sectional bonding area. The total numbers of specimens were 120, which were divided into 2 groups according to resin cements (Superbond C&B or Panavia F2.0) used and were further divided into 2 sub according to the testing times (1 day and 1 week). Each subgroups had 30 specimens (Field, 2009). All specimens were stored dry in the incubator at 24 degree Celsius until the testing time.

3.3 Testing method for microtensile bond strength

Once the specimen reached its testing time, it was aligned parallel to the Universal testing machine's jig (Instron 5566, Instron Ltd., Buckinghamshire, England) with cyanoacrylate adhesive (Model Repair II Blue, Dentsply-Sankin K.K., Japan) and tested at cross head speed of 1 mm./min. until it failed in tension. The load at failure was divided by cross-sectional area of the bonding surface to yield microtensile bond strength of a specimen.

3.4 Light microscope analysis and Scanning Electron microscope observation

The mode of failure of the bonded interface was determined visually under a light microscope (Nikon E-400 Pol CoolPIX990, Japan) at x25 magnification and then classified into adhesive, cohesive and mixed type of failures. Adhesive mode of failure was recorded if the resin cement was completely detached from the composite surface, cohesive if the bond failure was entirely within the resin cement and mixed if failure was a combination of the adhesive and cohesive modes of failures. Three specimens from each group were randomly selected to be observed under the scanning electron microscope (SEM) (JSM-6610LV JEOL Ltd., Tokyo, Japan) for modes of failures.

4. Results

The means and standard deviations of microtensile bond strength (μTBS) of resin cements in different time frames were showed in table 1. Two-way ANOVA revealed a significant main effect of time frames on the μTBS, F (1, 116) = 18. 8, p = 0.00003 and a significant main effect of the resin cements on the μTBS, F (1, 116) = 13.6, p = 0.0003. There was a nonsignificant interaction between the resin cements and the time frames, on the μTBS, F (1, 116) = 1.5, p = 0.22. Superbond C&B yielded more μTBS than Panavia F2.0. Tukey's Post Hoc test further revealed that the mean μTBS of these resin cements at 1 week was more than at 1 day.

Mode of failure was showed in figure 1. The type of failure in the Superbond C&B group at 1 day

Table 1 Means and standard deviations of microtensile bond strength of resin cements in different time frames

Resin cements	Times	Mean (MPa)	SD	95% Confidence Interval	
				Lower Bound	Upper Bound
Superbond C&B	1 day	20.24	3.66	18.99	21.48
	1 week	24.11	4.63	22.58	25.64
Panavia F2.0	1 day	18.52	3.17	17.27	19.76
	1 week	20.69	3.70	19.16	22.22

Was mixed failure (93.33%) followed by adhesive failure (6.67%) and at the 1week was mixed failure (76.67%) followed by adhesive failure (23.33%). In the Panavia F2.0 group the types of the failure at 1 day was adhesive failure (63.33%), cohesive failure (23.33%), and mixed failure (13.33%), and at 1week was adhesive failure (23.33%) and mixed failure (76.67%).

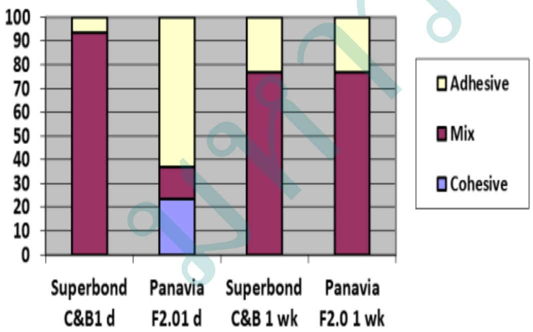

Figure 1 Mode of failure in Superbond C&B and Panavia F2.0 in difference time frames

5. Discussion

The results of the present study showed that the microtensile bond strength values of Superbond C&B at 1 day and 1 week were 20.24 MPa and 24.11 MPa whereas the values for Panavia F2.0 were slightly lesser at 18.52 MPa and 20.69 MPa, respectively. Similar values of these resin cements were demonstrated in the previous studies when bonded with different interfaces such as indirect composite, lithium disilicate, zirconia or even dentin (Kitayama et al., 2009; Mak et al., 2002; Salazar et al., 2013; Yanga et al., 2006).

In the previous studies, the increase in microtensile bond strength of Superbond C&B after storage for 30 days (Vaz et al., 2012) as well as of Panavia F2.0 after storage for 1 week was observed (Bandeca et al., 2010). On the contrary, it was reported that there was no significant change after storage for 150 days for Superbond C&B whereas Panavia F2.0 showed a decline of microtensile bond strength at the same storage time (Valandro et al., 2007). In this study, the authors found an increase in the microtensile bond strength between 1 day and 1 week as longer time interval might allow for an increase in the degree of polymerization. Transformation of monomers into polymers resulted in an increase in the overall microtensile bond strength (Ferrari et al., 2009; Mak et al., 2002).

It was found that the microtensile bond strength value of Superbond C&B was higher than Panavia F2.0. This might be because of the quantity and quality of the filler contained in the cements. During polymerization process, materials will shrink itself towards center. As a result, debonding occurred at the substrate interface (Davidson and De Gee, 1984).

An increase in the filler load decreased the volume of matrix and resulted in a decline of the bond strength (Mak et al., 2002). Even though filler was preferred due to its excellent physical property for strength, it could increase the stress during polymerization process, which impairs the adhesive interface causing a decrease in the bond strength and subsequently leads to a common cause of leakage failure of the resin cements in restorations (Ferrari et al., 2009; Fonseca et al., 2005). Thanks to an unfilled nature of Superbond C&B, minimal stress was found inside the material resulted in high microtensile bond strength and improving of the marginal seal (Mak et al., 2002; Oyagüeemail et al., 2009).

6. Conclusion

The microtensile bond strength values of both cements at 1 week were higher than that of 1 day. This should be studied further as it was crucial for postoperative instruction. Superbond C&B yielded higher microtensile bond strength than Panavia F2.0. Different types of resin cements could lead to significantly different values of microtensile bond strength and they are informative for selection. Further studies of microtensile bond strength in more time-intervals are suggested.

7. Acknowledgement

This research was partly supported by Faculty of Dental Medicine, Rangsit Univesity, Thailand.

8. References

Bandeca, M., Kassem, A., El-mowafy, O., Nadalin, M., Queiroz, R., Clavijo, V., & Saad, J. (2010). Influence of storage times on bond strength of resin cements to root canal. Materials research, 13, 25-28.

Chang, H., Noh, Y.-S., Lee, Y., Min, K., & Bae, J.-M. (2013). Push-out bond strengths of fiber-reinforced composite posts with various resin cements according to the root level. J Adv Prosthodont, 5, 278-286.

Darr, A. H., & Jacobsen, P. H. (1995). Conversion of dual cure luting cements. J Oral Rehabil, 22, 43-47.

Davidson, C., & De Gee, A. (1984). Relaxation of polymerization contraction stresses by flow in dental composites. J DENT RES, 63, 146-148.

El-Badrawy, W. A. (1995). Chemical versus dual curing of resin inlay cements. J Prosthet Dent, 73, 515-524.

El-Mowafy, O. (2001). The use of resin cements in restorative dentistry to overcome retention problems. J Can Dent Assoc, 67, 97-102.

El-Mowafy, O., Fenton, A., Forrester, N., & Milenkovic, M. (1996). Retention of metal ceramic crowns cemented with resin cements: effects of preparation taper and height. J Prosthet Dent, 76, 524-529.

Ferrari, M., Carvalho, C. A., Goracci, C., Antoniolli, F., Mazzoni, A., Mazzotti, G., Cadenaro, M., & Breschi, L. (2009). Influence of luting material filler content on post cementation. J DENT RES, 88, 951-955.

Field, A. (2009). Discovering statistic using SPSS (3rd ed.).

Fonseca, R. G., Santos, J. G. d., & Adabo, G. L. (2005). Influence of activation modes on diametral tensile strength of dual-curing resin cements. Braz Oral Res, 19, 267-271.

Kitayama, S., Nikaido, T., Maruoka, R., Ikeda, L., Zhu, M., Watanabe, A., Foxton, R. M., & Miura, H. (2009). Effect of an internal coating technique on tensile bond strengths of resin cements to zirconia ceramics. Dental Materials Journal, 28, 446–453.

Mak, Y.-F., Lai, S. C. N., & Cheung, G. S. P. (2002). Micro-tensile bond testing of resin cements to dentin and an indirect resin composite. Dent materials, 18, 609-621.

Minami, H., & Tanaka, T. (2013). History and current state of metal adhesion systems used in prosthesis fabrication and placement. Journal of Oral Science, 55, 1-7.

Oyagüeemail, R. C., Monticelli, F., Toledano, M., Osorio, E., Ferrari, M., & Osorio, R. (2009). Effect of water aging on microtensile bond strength of dual cured resin cements to pre-treated sinterered zirconium-oxide ceramics. dental materials, 25, 392-399.

Salazar, M. S. M., Mutlu, Ö., Regina, A., Antonio, B. M., & Felipe, V. L. (2013). Effect of resin cement type on the microtensile bond strength to lithium disilicate ceramic and dentin using different test assemblies. J Adhes Dent, 15, 361-368.

Valandro, L. F., Özcan, M., Amaralc, R., Leite, F. P. P., & Bottino, M. A. (2007). Microtensile bond strength of a resin cement to silica-coated and silanized in-ceram zirconia before and after aging. Int J Prosthodont, 20, 70-72.

Vaz, R. R., Hipolito, V. D., D'Alpino, P. H., & Goes, M. F. (2012). Bond strength and interfacial micromorphology of etch-and-rinse and self-adhesive resin cements to dentin. J Prosthodont, 21, 101-111.

Yanga, B., Ludwiga, K., Adelungb, R., & Kern, M. (2006). Micro-tensile bond strength of three luting resins to human regional dentin. Dental Materials Journal, 22, 45-56.