Marginal fitness and marginal leakage of fiber-reinforced composite crowns depending upon luting cements

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Purpose: The purpose of this *in-vitro* study is to compare the marginal fitness and microleakage of the fiber-reinforced composite crowns (Targis/Vectris) cemented with various luting agents after thermocycling and dye penetration technique.

Materials and Methods: Fifty crowns were randomly assigned to 5 groups and cemented on the prepared natural extracted premolars with five different luting cements (Bistite II, Super-Bond, Variolink II, zinc phosphate, and glass-ionomer cement). After 24 hours of cementation, all specimens were thermocycled three hundred times in water baths of 5°C and 55°C with 60 s soaking time. The marginal gap and leakage of each specimen were measured and recorded by a digital measuring microscope.

Results: The mean values of marginal discrepancy were 46.78 μm for Bistite II, 56.25 μm for Variolink II, 56.78 μm for Super-Bond, 99.21 μm for Fuji-I glass-ionomer cement, and 109.49 μm for zinc phosphate cement. There were significant differences in the marginal fit among three different cement systems (resin, glass ionomer, and zinc phosphate cement) ($p<0.01$). The less microleakage between tooth-cement and restoration-cement interface was observed in the order of Variolink II, Bistite II, Super-Bond, glass-ionomer, and zinc phosphate.

Conclusion: Specimens luted with resin cements (Bistite II, Super-Bond, Variolink II) exhibited less marginal leakage and marginal discrepancy than those of conventional glass-ionomer and zinc phosphate cement. **(Int Chin J Dent 2002; 2: 33-47.)**

INTRODUCTION

Due to an increase of esthetic demands, the development of various esthetic restorative materials has been accelerated. As a result, both patients and practitioners have a wide choice of various esthetic materials and have increased the usage of restorative and luting materials, composite resin and all ceramic crowns. Among the characteristics of the composite resin, esthetic and physical property is outstanding. However, because of its strength, hardness, and wear resistance, there is a limitation in using the composite resin for a molar area.[1-3] In addition, ceramic crowns break easily and make the opposite tooth worn out. In order to improve the physical properties of composite resin, in the middle of 1990's, the new material called *cer*amic optimized poly*mer* ('Ceromer' hereinafter) was developed and reported. It can be used for a molar area, by a virtue of the improvement of physical properties, to be fabricated indirectly and to contain ceramic fillers with a high level of density. Because of the impregnation of reinforced fibers in the resin matrix, the fiber-reinforced composite ('FRC' hereinafter) has high strength and can be available for esthetic restorations instead of metal restorations. It is also called glass fiber composite, fiber-reinforced polyceramic composite, etc.[4-8]

As a second generation of the composite resin, which is a piece of important developments of prosthodontics, the Ceromer and FRC have not only esthetic advantages, but also the resemblance of wear and strength of natural tooth.[6,9] And they have the shock absorption capability, in addition. Because of the advantages above, the bruxism patients' interest in the resin has been increasing as it was deemed as a superstructure material of dental implants. Also, Ceromer and FRC are easy to be bonded and repaired on a orthodontic bracket, that are unseen advantages in other restorative materials.[9]

Loose and others[10] compared the fracture strength between In-Ceram and Targis/Vectris. After thermocycling and mechanical loading, the FRC showed significantly higher fracture strength than In-Ceram does. According to the Tysowsky's report,[11] the Targis restoration was successfully completed through Targis being luted with zinc phosphate or conventional glass-ionomer cement. During the test of "facing repair" of fiber-reinforced composite restoration, Rosentritt[12] found out that the repair of fiber reinforced composite can be attained through the usage of aluminum-oxide air-abrading pretreatment and silanization. Although the advantages of physical properties and ease of manipulation were reported, the vitro studies and clinical researches on marginal fitness and marginal leakage have not been conducted as it is a new material.

The marginal fit and marginal leakage of the dental restoration are important measurements of clinical success. Microleakage is defined as the passage of bacteria, chemical substances, molecules and ion fluids between a tooth and its restoration.[13] The absence of sealing at the restoration margin promotes discoloration, adverse pulpal response, postoperative sensitivity and recurrent caries.[14,15] The dye penetration has been utilized by several investigators to assess the presence of marginal leakage.[16-18]

The physical properties of luting cement change, following a special environment, oral cavity. That is, a thermal expansion coefficient of tooth substances, cement, restoration and stress distribution in cement, difference of film thickness, water absorption. For most luting agents, microleakage occurs at the interface between a treated tooth and its cement. In a stressed situation, a weakest link breaks first, and White et al.[19] indicated that the interface was the weakest link. They also found that the zinc phosphate cement caused a greater degree of microleakage than glass-ionomer and resin cements did. Tjan et al.[20] found that margins placed on dentin did not showed significantly greater microleakages than those on enamel. Gutzmann and others[21] reported that thermal changes and lapse of time after cementation had an effect on marginal leakages of the composite resin restorations. And Bahaloo et al.[22], and Retief[23] reported that the use of acid etching technique and dental bonding agents showed an increase of the retention of restorations and a reduction of marginal leakage.

Although there is no report on the marginal fitness of FRC restorations, porcelain-fused-to-metal (PFM) crowns and all ceramic crowns have been studied. Faucher et al.[24] reported on the marginal fitness of PFM crowns in cervical margin forms. Schneider et al.[25] reported on the marginal fitness of collarless-type PFM crowns in various fabrication methods. Shoher et al.[26] compared the marginal fitness of all ceramic crowns and metal crowns. And Morris and Sorensen et al.[27] studied the marginal fitness of all ceramic crowns, collarless porcelain fused-to metal crowns and metal crowns. Freilich et al.[28] recommended a round shoulder or deep chamfer adding a ladder-type preparation on lingual or proximal surface, but a 0.5 mm-short chamfer margin is recommended recently.

There is no report suggesting the cementation of fiber reinforced composite resin restoration with zinc phosphate or glass-ionomer cement, but, when considering a clinical variation, conventional cementation above can be considered. Also, the use of dual cured resin cement (Variolink, Ivoclar-Vivadent, Liechtenstein), which is manufacturer's recommendation, may require additional time and economic costs.

This study evaluated the marginal fitness and marginal leakage of zinc phosphate and glass-ionomer cement that are used in the cementation of reinforced composite crown, and compared them with those cemented with three resin cement systems (Bistite II, Super-Bond C&B, and Variolink II).

MATERIALS AND METHODS

Materials

Fifty non-carious human premolar teeth, which had been stored in saline since their extractions due to orthodontic considerations, were used in this study. The teeth were imbedded with a orthodontic clear resin (Ortho-jet resin, Lang, USA) and were randomly divided into five experimental groups of 10 teeth each. Subsequently, we luted Targis/Vectris crowns with zinc phosphate cement (Mizzy, Inc, NJ, USA), glass-ionomer (Fuji I, G-C International, Tokyo, Japan), Bistite II (Tokuyama, Co. Ltd., Tokyo, Japan), Super-Bond C&B (Sun Medical, Corp., Shiga, Japan), and Variolink II (Ivoclar-Vivadent, Schaan, Liechtenstein) as luting cements (Table 1).

Table 1. Luting cements used in this study.

Luting cements	Manufacturer
Bistite II	Tokuyama Co. Ltd., Tokyo, Japan
Super-Bond C&B	Sun Medical Corp., Shiga, Japan
Variolink II	Ivoclar-Vivadent, Schaan, Liechtenstein
Zinc phosphate	Mizzy Inc., NJ, USA
Fuji I glass-ionomer	G-C International, Tokyo, Japan

Tooth preparation and model fabrication

Each tooth was cleaned with a hand scaling instrument, rubber cup and slurry of pumice. The coronal portion of each tooth was prepared for a complete crown with nearly parallel walls and a deep chamfer finish line by the use of diamond bur at a high speed, and by cooling with an air and water spray. As part of the tooth preparation, a total of 50 impressions were made with polyvinylsiloxane (Examix G-C Corp., Tokyo, Japan), dies were made from Type IV dental stone (Silky-Rock, Whip Mix), with a powder/water ratio of 50 mg/12 mL. The stone dies were divided into five groups. And each group was composed of 10 dies.

Targis-Vectris crown fabrication

The dies were coated with two layers of a die relief spacer and a Targis die separation solution, and then, were coated with a Targis base. Glue was used to coat the occlusal surface. Vectris was placed, for the single crown, on the occlusal surface and slightly pressed with the carver, then cured on the Vectris VSI. The removed Vectris from the die was placed into the model to make sure that it fitted, and was made smooth with a carbide bur above 1 mm from the margin. Then, the inner surfaces of all crowns were microblasted with the 50 µm aluminum oxide and were steam cleaned. The inner surface of Vectris was coated with a wetting agent to make sure that it fitted. A base was put on the margin. Each coated surface was pre-cured with Targis Quick for 20 s. The surface was cleaned right after the curing with sponge to make sure that the base had been evenly coated. After building Targis with the modeling instrument, each surface was pre-cured for 10 s with Targis Quick. For the final step, all surfaces were evenly coated with Targis Gel and were cured for 25 minutes with the Targis power.

Measurement of marginal fitness before cementation

After the try-ins of fifty restorations without any cement, the marginal fit of each restoration was examined at a x50 digital microscope (Nikon MMII). Four vertical lines were inscribed onto the die approximately 0.5 mm below the margin on the midmesial, midbuccal, midpalatal, middistal surfaces through a 0.25 mm round carbide bur. These vertical lines were used to help orient the digital microscope for a marginal discrepancy measurement (Fig. 1).

Cementation of Targis-Vectris crowns

Before any cementation, the tooth-preparations were lightly pumiced and thoroughly cleaned with water, and then dried with compressed air. Each crown was then filled with a sufficient amount of cement to evenly cover the inner surfaces, and was seated on the tooth with a digital pressure. Afterwards, it was sustained under a 3 kg static load for 10 minutes with a loading device (Saiki A-100, Tokyo, Japan).

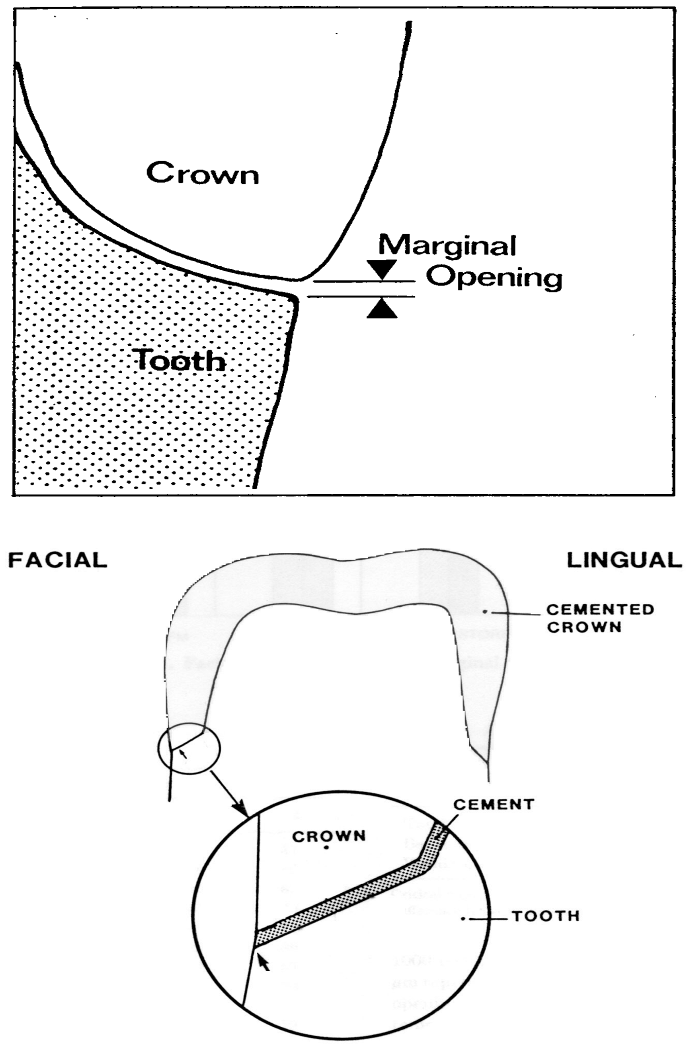


Fig. 1. Measuring point of marginal opening.

Group 1: Bistite group

The inner surfaces of 10 Targis/Vectris crowns were sandblasted. Also, Primer 1(A/B) of which main component is phosphoric acid monomer (demineralization of tooth substance and enhancing bonding to tooth) was mixed with an equal amount and coated and then dried for 30 s. Primer 2 was coated and then, dried for 20 s. And, after these crowns were luted with the Bisteite II resin cement, light-cured for 60 s.

Group 2: Super-Bond group

The inner surfaces of 10 Targis/Vectris crowns were sandblasted. Dentin surfaces were treated with the Green activator (10% citric acid, 3% ferrous dichloride solution) for 10 s. The crowns were luted with Super-Bond cement after washed and dried.

Group 3: Variolink II group

The inner surfacse of 10 Targis/Vectris crowns were sandblasted, and were acid-etched with a 37% phosphoric acid. Dentin surfaces were treated and each inner surface was silanated with Monobond. The crowns were luted with the Variolink II cement after covered with a dentin adhesive coating and light-cured for 60 s.

Group 4: Zinc phosphate group

The inner surfaces of 10 Targis/Vectris crowns were sandblasted and were luted with a zinc phosphate cement without any special tooth surface treatment.

Group 5: Glass-ionomer group

The inner surfaces of 10 Targis/Vectris crowns were sandblasted and were luted with a conventional glass-ionomer cement without any special tooth treatment.

Thermocycling

Each specimen was stored in saline for 24 hours before thermocycled. And then, each was subjected to 300 temperature cycles between 5˚C and 55˚C with a 1-minute dwell time in a water bath containing a 0.5% aqueous solution of a basic fuchsin dye.

Observation of marginal fitness after cementation

After the cementations of fifty restorations the marginal fit of each restoration was examined at x50 digital microscope (Nikon MMII). Four vertical lines were inscribed onto the die approximately 0.5 mm below the margin on the midmesial, midbuccal, midpalatal, middistal surfaces through a 0.25 mm round carbide bur. These vertical lines were used to help orient the digital microscope for the marginal discrepancy measurement (Fig. 1).

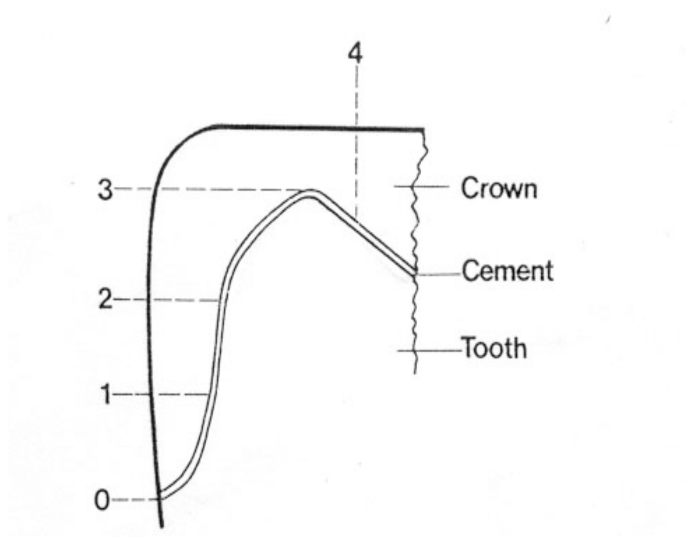
Data for each marginal fitness were separately analyzed with the Kruskal-Wallis one-way analysis of variance. The Duncan test was used for a comparison in the group. The clinical relevance of the results was interpreted by the comparison with the acceptable marginal discrepancy of 120 μm as proposed by McLean and von Fraunhofer.[29]

Observation of marginal leakage

The specimens were rinsed after thermocycled. And then, each tooth was sectioned 1) longitudinally through the center of the restoration 2) facioligually and mesiodistally, with the Isomet low-speed diamond saw (Behler Ltd.). Each piece was polished by the #400 and #1,000 grit silicon carbide sandpapers. The extent of the dye penetration at the facial, lingual, mesial, and distal margins was assessed along both the tooth-cement (T-C) and the restoration-cement (R-C) interfaces with a microscope at x100 magnification (Microscope Nikon MMII) and was scored according to the following scale (Fig. 2).

The marginal leakage for each crown at each interface was the average score of the dye penetration recorded from the facial, lingual, mesial, and distal margins.

The data for each interface (T-C and R-C) were separately analyzed with the Kruskal-Wallis one-way analysis of variance. The Duncan test was used for the comparison in the group.



0 – No microleakage
1 – Microleakage to one third of axial wall
2 – Microleakage to two thirds of axial wall
3 – Microleakage along full length of axial wall
4 – Microleakage over occlusal surface

Fig. 2. Diagram of criteria for scoring values of microleakage.

RESULTS

Marginal Fitness

1) Before cementation

The mean and standard deviation was 35.7 ± 7.3 µm and there was no significant difference among groups.

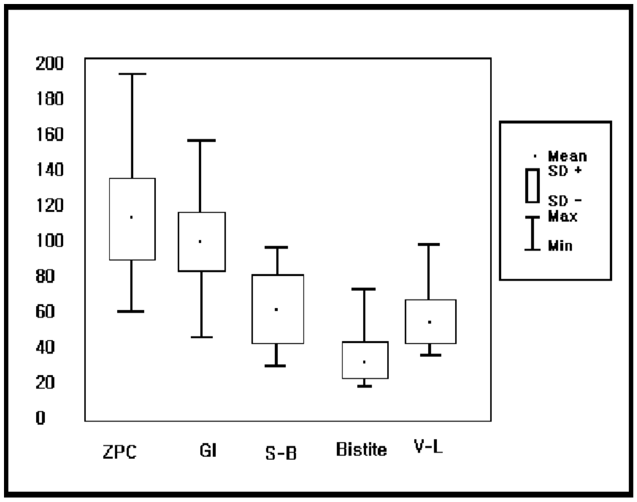
2) After cementation

The five luting cements yielded comparable marginal fits. They demonstrated marginal openings in the range of 46.7 to 109 µm. The mean values of the marginal fit were 46.78 µm for Bistite, 56.25 µm for Variolink II, 56.78 µm for Super-Bond, 99.21 µm for glass-ionomer, and 109.49 µm for zinc phosphate.

The Bistite II cement had the lowest marginal discrepancies, and the zinc phosphate cement had the greatest. The statistical analysis indicated significance in the marginal fit among the five groups. The raw data, means, and standard deviation of the marginal fit values are listed in Table 2. The mean marginal gaps are illustrated graphically in Fig. 3.

Marginal leakage

The marginal leakage scores, median, and range of the five test groups are presented in Table 3. The mean values of tooth-cement interface and, restoration-cement interface were 0.225 and 0, respectively, for Variolink II, 0.325 and 0, respectively for Bistite, 0.325 and 0.025 for Super-Bond, 0.675 and 0.025 for glass-ionomer, 1.125 and 0.15 for zinc phosphate. An analysis of the data for the T-C and R-C interfaces indicated a statistically significant difference at p<0.001. The Kruskal-Wallis test indicated that the crowns cemented with the resin cement produced significantly less microleakage, compared with those luted with zinc phosphate and glass-ionomer.



ZPC: Zinc phosphate; GI: Glass-ionomer; S-B: Super-Bond; Bistite: Bistite II; V-L: Variolink II

Fig. 3. Marginal fitness (μm).

Table 2. The mean standard deviation of marginal fit of Targis-Vectris restorative material in each different luting materials (μm).

Luting cement	Surface	Mean	SD
ZPC	Facial	122.6	36.37
	Mesial	106.2	40.6
	Lingual	105.1	38.79
	Distal	104	32.31
Glass-ionomer	Facial	87.05	20.55
	Mesial	108.1	37.62
	Lingual	109.7	35.39
	Distal	91.95	34.05
Bistite II	Facial	39.4	8.14
	Mesial	45.3	15.47
	Lingual	51.35	11.76
	Distal	51.05	13.36
Super-Bond	Facial	49.45	18.64
	Mesial	60.85	18.57
	Lingual	60.05	23.68
	Distal	56.75	17.43
Variolink II	Facial	51.71	12.96
	Mesial	58.69	10.37
	Lingual	58.2	14.41
	Distal	56.4	18.92

Table 3. Raw score, mean, range of microleakage.

	ZPC		GI		Bistite II		Super-Bond		Variolink II	
Specimen number	**T-C**	**R-C**	**T-C**	**R-C**	**T-C**	**R-C**	**T-C**	**R-C**	**T-C**	**R-C**
1	1.5	0.25	1	0	0.25	0	0.25	0	0.25	0
2	0.5	0	0.25	0	0.25	0	0.25	0	0.25	0
3	1.5	0.5	0.25	0	0.75	0	0.5	0	0.25	0
4	1.75	0.25	1.5	0.25	0.75	0	0.25	0	0.25	0
5	1.25	0.15	0	0	0	0	0	0.25	0	0
6	0.25	0	0.25	0	0.25	0	0.75	0	0	0
7	0.75	0	0.25	0	0.5	0	0.25	0	0.5	0
8	1.5	0.25	0.75	0	0.5	0	0.25	0.25	0.25	0
9	1.5	0.25	0.75	0	0	0	0.25	0	0.25	0
10	1.5	0.25	0.25	0	0.5	0	0.25	0	0	0
Mean	1.12	0.15	0.68	0.025	0.325	0	0.325	0.025	0.225	0
Range	1.75	0.25	1.5	0.25	0.75	0	0.75	0.25	0.75	0

T-C: Tooth-cement interface; R-C: Restoration-cement interface.

DISCUSSION

Fiber-reinforced composites are resins strengthened by long, continuous fibers. Products are available as either free fibers, which require incorporation of a resin, or pre-impregnated fibers. The concept of using fiber-reinforced composites in dentistry is intuitively appealing and has been discussed in literatures for many years. However, it is only recently that these systems have gained general clinical acceptance.[29] The new fiber-reinforced composite (FRC) system, Targis-Vectris, which was introduced recently, is also indicated for the use in single crowns and multiple-unit posterior restorations. Touati[30] classified Targis as a second generation of laboratory composites together with ceramic polymer, polyglass and Ceromer. Targis is easy to produce and is high in fracture strength and in elasticity, which made a tooth preparation easy. In addition, it contains 80% of filler and during the process of fitting, the risk of fracture is reduced.

Marginal fitness is one of the most important criteria used in the clinical evaluation of fixed restorations.[31-34] Marginal fitness means the distance between the margin of a restoration and the margin of a prepared abutment tooth. A poor marginal fitness causes microleakages and results in the hypersensitivity of tooth, dental plaque accumulation, gingivitis, dental caries, etc. However it is very hard to produce a prosthesis, which is esthetically satisfying, has a good marginal fitness, and has a margin form that prevents plaque accumulation.[35]

Deformations of model due to an incorrect impression taking, deformation during a laboratory procedure and, a polymerization shrinkage are the factors that decrease the marginal fitness.[36-37] The marginal fitness of restoration depends on digital pressure during a cementation procedure, viscosity of cement, temperature, humidity and type of dentin adhesive.[38] In FRC, like in all ceramic crowns, a marginal fitness variation can occur according to a film thickness because it is pressed by only a digital pressure in order to avoid any fracture during such cementation.

Film thickness is dependent on the viscosity of mixed cement. A study[39] showed that there could be a discrepancy among Bistite II (10 μm), Variolink II (32 μm), Super-Bond (30-60 μm), and glass-ionomer (15-30 μm) based on the mixing methods. Ideally, the cement that has a low film thickness makes the good seating of the prosthesis possible. So the cement with a lower film thickness is recommendable. However, though a low film thickness cement is used, high a film thickness can occur according to the shape of prepared abutment tooth, cementation method, the viscosity of cement and the cement type. And it results in poor marginal adaptation and marginal leakage from solubility of cement.

Windeler and Palermo et al.[40] reported that a high film thickness occurs when zinc phosphate is mixed in a traditional way. Wilson et al.[41] observed that glass-ionomer showed over a 41 μm film thickness. Fusayama and Iwamoto, Jorgensen[42] reported that the correlation between compressive load and film thickness during a cementation showed a hyperbola pattern that the critical point of the hyperbola was about 30 μm and, when the cement was compressed by a static load of 25-30 μm, the increasing compressive static load could hardly get a desired decrease in the film thickness, but the dynamic load can did.

It is known that an adhesive luting with a composite cement gives the best bond to Targis/Vectris and is, therefore, recommended.[43,44] But, clinical situations are variable, a conventional cementation may be needed. The zinc phosphate cement, which has been used in a clinical dentistry for over 90 years,[45] is weak in chemical bonding. So the taper, length and surface area of the tooth preparation are critical to the success.[46] Several studies have demonstrated significant linear penetration of silver nitrate from the external margin along the restoration-tooth interface after a crown cementation.[47,48] With a long term laboratory observation and a clinical test, it is possible to do all ceramic crowns between the casting post, inlay, onlay, cast gold crown and bridge, and tooth surface, amalgam, composite, glass-ionomer core build-ups. The glass-ionomer cement is adhesive to tooth's enamel and dentin,[49] and it has been used in clinical dentistry for a while because of its stability, matrix structure,[50] fluoride release,[51] and decrease in marginal leakage.[52] On the other hand, there is a limitation as in a long setting time and dehydration during an initial setting.[53,54]

The presence of marginal discrepancy and microleakage in the restoration exposes the luting agent to the oral environment. The larger the marginal discrepancy and subsequent exposure of the dental luting agent to oral fluids, the more rapid the rate of cement dissolution is. The resulted microleakage permits the percolation of food, oral debris, and other substances that are potential irritants to the vital pulp.

The occurrence of microleakage with the zinc phosphate and glass-ionomer cements in this study was expected. A number of papers have found that the tensile, compressive, and shear strength of zinc phosphate and glass-ionomer cements are lower than those of the resin cement.

Villaroel[55] and others showed by comparing the microleakage under the cycling loading (100 N, 1.6 Hz, 2 million cycle) between the resin modified glass ionomer cement and the adhesive resin cement that the marginal leakage can be effectively prevented. Knox[56] found no difference between with or without the loading stage. The tooth surface treated with a dentin bonding agent and micromechanical bonding enhances the restorative material's margin sealing effect. Ivoclar Co. observed that the shear bond strengths of dual cement and glass-ionomer cement used for the Targis/Vectris restorative material. The shear bond strength of the dual cement was 20-30 MPa, and that of the light-curing glass-ionomer cement was 15 MPa. Also, the adhesive bonding did not occur with the zinc phosphate cement and glass-ionomer cement. Therefore, the manufacturer, Ivocar, recommends the adhesive luting cement.

A composite resin cement, which is outstanding in chemical and mechanical bonding strength is generally used for the luting of the fiber-reinforced composite resin. Variolink II, which was recommended by its manufacturer, Bistite II resin-cement and , Super-Bond were used in this study. The Variolink II cement, which belongs to the group of Bis-GMA + UDMA, is composed of three kinds of different viscosities and five kinds of translucent shades. It is esthetic and continuously releases fluoride, which prevents recurrent caries in a marginal area. In addition, since it is transparent, it fits with surrounding teeth well. But, a clinical error may occur because the bonding process is complicated. The Bistite II cement is an adhesive resin cement, which has a superior bonding strength and is easy to handle with. It strongly bonds to tooth, metal, composite resin and porcelain by the match and the new composition of adhesive Monomer MAC-10. Because it is a 2-paste, dual cure type, handling is easy. The Super-Bond cement, which belongs to the group of the 4-META/MMA-TBB resin, is good for the pulp conservation because it prevents a bacterial penetration through dentinal tubule and a microleakage by producing hybrid layer and marginal sealing. But, it is hard to handle with, and the prosthodontic marginal discrepancies can be happened by thick layers resulted from improper handling. In a special environment, such as an oral cavity, the physical properties of the resin cement can be changed. In other words, a marginal leakage may occur because of the differences of coefficients in thermal expansion, polymerization shrinkage of resin cement, stress distribution within cement, solubility, moisture absorption, and the effects on the retention of prosthesis.

The experiments on the marginal leakage and marginal fitness have been usually done using metal or resin dies. However this study was done with natural teeth because the tooth treatments for the five different cements were not the same. But there was a limitation in simulating the oral environment exactly, thus, the results of this study would not be able to be adapted to a clinical situation as a whole.

In this study marginal leakages occurred in all experimental groups. It suggested that it is caused by the discrepancies among the cement, tooth substance and thermal expansion coefficient during the thermocycling.

There are disagreements as to what a clinically available limit is on the cervical margin according to the researcher. Christensen[57] reported that the clinically available limit in a cervical area is 34-119 μm in inlay cases. McLean et al.[29] surveyed 1,000 restorations for 5 years and reported that 120 μm was the clinically available limit. Assif[58] reported that 140 μm was the clinically available limit. The results of this study showed that the clinical available limits were 46.78 μm for Bistite, 56.25 μm for Variolink II, 56.78 μm for Super-Bond, 99.21 μm for glass-ionomer, 109.49 μm for zinc phosphate and all the five cements showed lower values than those in any of the value of any of the aforementioned reports.

Tjan and Drdent et al.[59] reported that the resin cement (Panavia EX) exhibited a substantially lesser margnal leakage than those cemented with a zinc phosphate cement. Of the three resin cements in this study, the dye-penetration-to-restoration-cement interface was not observed in Bistite II and Variolink II.

The results of this study showed that the dental cement has a crucial relationship with the fitness of restoration, and a low film thickness cement enables the good seating, and the cementation of prosthesis should use a cement with, a proper strength, bonding strength and low film thickness.

Marginal leakage was low for the resin cements and it is thought that Variolink II, Bistite II, Super-Bond can be used clinically with advantages. But marginal leakage occurred even for the resin cements after thermocycling. It implies that the study for a precise laboratory technique and development for the resin cement, which has a thermal expansion coefficient similar to natural tooth, and can sustain the marginal sealing in spite of a stress change due to a thermal change, and can be used with ease, is needed.

CONCLUSIONS

This study evaluated and compared the marginal leakage and marginal gaps of Targis/Vectris crowns cemented with various cements. Within the limitations of this study, the following conclusions were made based on the results.

1. The mean values of the marginal fits were Bistite (46.78 μm), Variolink II (56.25 μm), Super-Bond (56.78 μm), glass-ionomer (99.21 μm), zinc phosphate (109.49 μm) each.
2. The mean values of tooth-cement interface, restoration-cement interface increased Variolink II, Bistite II, Super-Bond, glass-ionomer, zinc phosphate in order. Analysis of the data for T-C and R-C interfaces indicated a statistically significant difference at $p<0.001$.
3. Crowns luted with resin cements (Bistite II, Super-Bond, Variolink II) exhibited less marginal leakage and marginal gap than those luted with conventional glass-ionomer and zinc phosphate cements.
4. The results indicated that, of all five luting systems, resin cements yielded excellent marginal fitness and marginal leakage, on the contrary, glass-ionomer and zinc phosphate cements showed applicable marginal sealing and that the cements can be used according to the cases and indications.

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