CHAPTER III

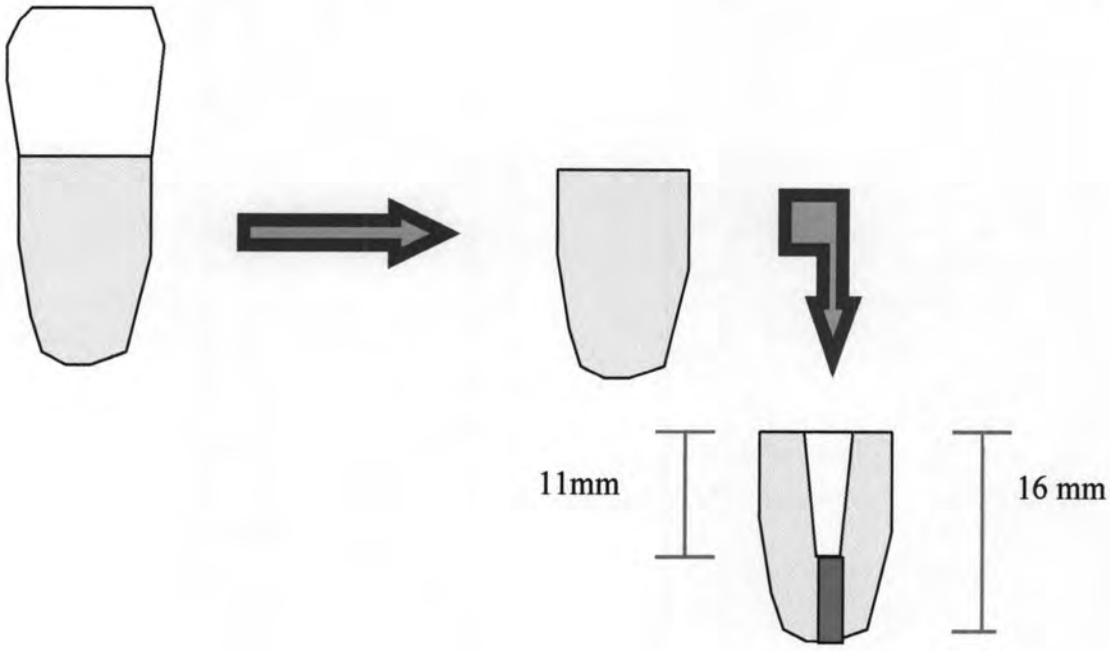
MATERIAL AND METHODS

This study has been approved by the ethic committee of Chulalongkorn University. Eighty maxillary central incisors and maxillary canines were used. Teeth with root resorption, caries or cracks were excluded. All selected teeth have almost similar in length, shape and dimension. All of them have straight canals. External debris was removed with an ultrasonic scaler and the teeth were stored in 0.9% normal saline solution prior to the study. All teeth were decoronated at cemento-enamel junction with approximately 16 mm of root left using low speed cutting machine (ISOMET 1000, Buehler, Lake Bluff, IL, USA). The coronal diameter at the orifice was measured with the digital caliper (Mitutoyo Corperation; Kanagawa, Japan) and specimens presented with diameter larger than that of the DT-light post #3 (R.T.D., St. Egreve, France) (1.95 mm) were discarded. The coronal part of the canal were enlarged using sizes 1-3 Gates Glidden burs (Dentsply/Maillefer, Ballaigues, Switzerland) in a descending order of 1mm coronally to the apical foramen. All roots were shaped uniformly at full working length to size 50 using K-file (Dentsply/ Maillefer, Ballaigues, Switzerland). This was followed by a step back preparation to size 70. Irrigation was performed with 2.5% NaOCl solution after every change of file throughout the cleaning and shaping of the root canal. After shaping, the teeth were dried with paper points and the root canal was filled with gutta percha (Dentsply/ Maillefer, Ballaigues, Switzerland) and zinc oxide eugenol based sealer (Grossmann formula, product of faculty of dentistry, Chulalongkorn University, Thailand) using lateral condensation technique. Coronal surplus was removed with heat excavator and the orifices were temporary filled with Cavit (3M ESPE, Seefeld, Germany) and stored for a week at 37° C in 100% humidity.

The samples were randomly divided into eight groups of ten teeth each. The root canal of each sample was further enlarged with low speed drill provided by the manufacturer of the fibre reinforced post system to #3 with post space length of 11 mm (Figure 1). D.T. light post #3 was then tried in and later luted with different luting

cements according to each of the manufacturer's recommendation. The luting cements used in this study were demonstrated in table 1.

Fig. 1. preparing post space.



For Superbond C&B, there are two etching solutions; in this study the green solution was used. Since Panavia F 2.0, Maxcem Elite, and Rely X Unicem are dual cured luting cement, they were light cured as the manufacturer's recommendation using light curing source Epilar Trilight (3M ESPE, St.Paul, MN, USA) with the light intensity of 550 mW/cm^2. Radiography was performed on mesiodistal and buccolingual direction on each sample to check for imperfection between post and root canal dentin. The specimens with imperfection shown in the radiograph were discarded. All specimens were stored in 37°C, 100% humidity for 24 hours

After 24 hours storage, each specimen in 4 groups (4 types of luting cement) was embedded in a PVC cylinder (height: 20 mm, outer diameter: 22 mm) filled with acrylic resin (LECO Corporation, St. Joseph, MI, USA) up to 2 mm of the most coronal portion of the specimens. The long axis of the specimens was embedded perpendicular to the

horizontal plane. The simulating of periodontal ligament was performed using silicone sealant Unicorn 5200 (Unicorn Building Chemical Co, Ltd., Nontaburi, Thailand). Then the specimens were stored again in distilled water at 37°C 24 hours before testing.

Table 1. Presents group of teeth according to luting cement and mechanical cyclic loading.

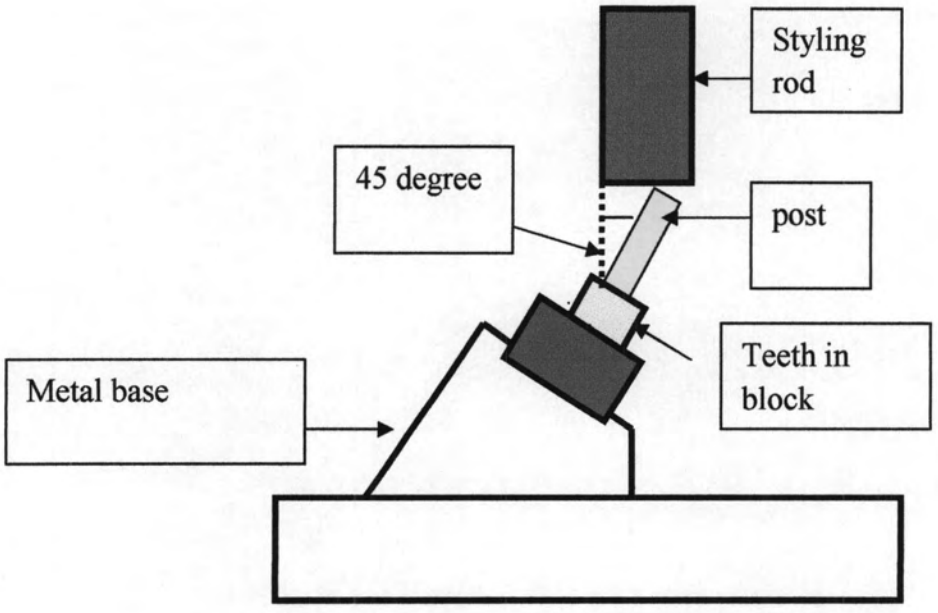
Luting cement	0 cycle	1,000,000 cycle
Superbond C&B (Sun Medical, Moriyama City, Japan)	G1	G5
Panavia F 2.0 (Kuraray, Osaka, Japan)	G2	G6
Maxcem Elite (Kerr, Orange, CA, USA)	G3	G7
Rely X Unicem (3M ESPE, Seefeld, Germany)	G4	G8

Cyclic loading

Specimens in group G5, G6, G7, G8 were submitted to cyclic loading (Figure 2). They were placed in a metallic base at 45- degree angle, so that a flat end with 10 mm diameter of the upper rod of the universal testing machine (Instron 8872, Instron, Fareham, UK) could make a pulse load of 50 N, at a frequency of 2 Hz, directly on the post. The root portion of the specimen was immersed in water at room temperature (26±2°C). One million cycles were executed, simulating approximately 5 years of clinical service (23, 28, 57). For standardization of the water storage, specimen in G1-G4

were stored in distilled water (26±2°C) for 6 days which equal to a hundred million cycles of cyclic loading.

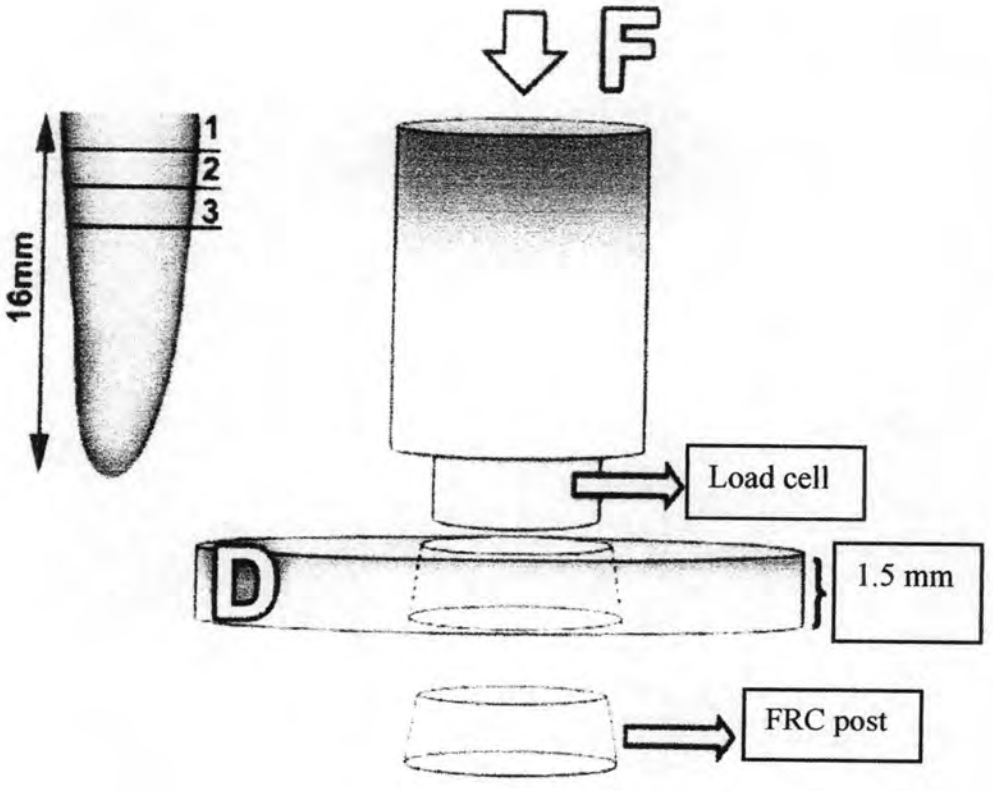
Fig. 2. Diagram of specimen set up for cyclic loading.



Push out test.

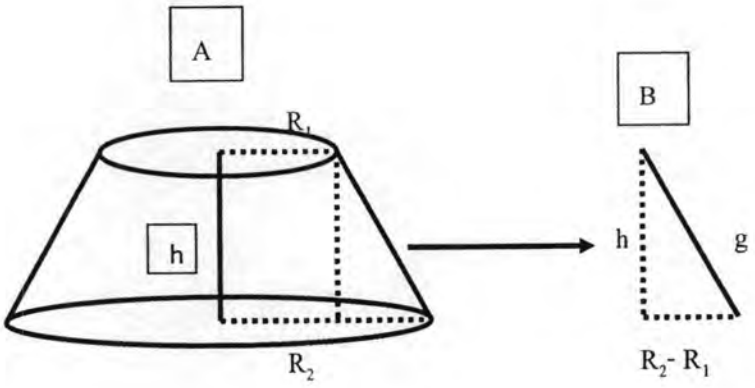
After cyclic loading, all specimens in G1-G8 were prepared for push out test. Specimens were sliced perpendicular to the long axis of the root using low speed cutting machine (ISOMET 1000, Buehler, Lake Bluff, IL, USA) under copious water. The first cervical slice (approximately 1mm) from cemento-enamel junction was discarded, given that the excess of cement in that region could influence the result of the adhesive strength (24). Then each tooth was sliced into three slabs with 1.5mm thickness. The larger diameter of post side of the specimen was faced opposite to the direction of load. The specimen was fixed on metal platform with sticky wax. Push out test was performed using a universal testing machine (Instron 8872, Instron, Fareham, UK) with a cross head speed of 1mm/min. The maximum failure load was recorded when debonding between post and root canal dentin occurred (Fig 3)

Fig 3 Pust out test , (D=dentin, F=load)



The bond strength (σ) was converted into MPa by means of formula σ (bond strength) = F/A; where F=maximum failure load (N) and A=adhesive surface area (mm^2). Adhesive surface area is the lateral area of geometric figure circular straight cone trunk of parallel bases calculated by using the following equation; $¶\times[h^2+(R_2- R_1)^2]^{1/2}\times(R_1+ R_2)$ when ¶ = 3.14, h = specimen thickness, R_1, R_2 = radius of the post measuring from the internal diameters of the smaller and larger side of the post, respectively (24). The three calculated bond strength of the specimens from the same root were averaged and represented as bond strength of that particular specimen (Figure 4).

Fig. 4. adhesived area calculation



Scanning electron microscope:

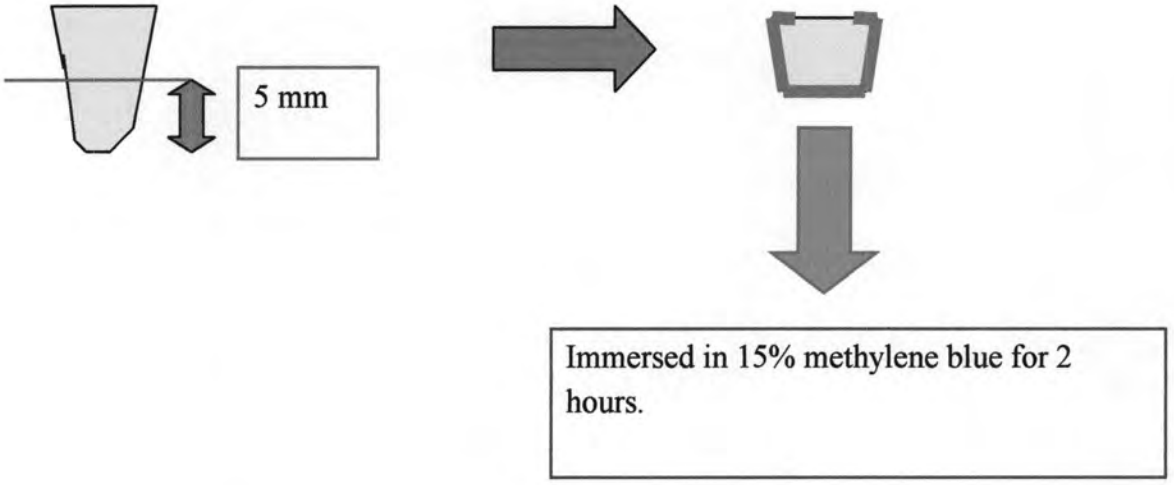
Debonded specimen surfaces of G4, G8 and only dentin surface of G1-G3 and G5-G7 were gold sputter-coated and viewed using a scanning electron microscope (SEM) (JSM-5410LV, JEOL, Tokyo, Japan) at 5000X magnification to observe the fracture surfaces on intraradicular dentin sides.

Microleakage evaluation.

After push out test, all the roots from all groups (G1-G8) were prepared for microleakage evaluation, each specimen was made by cutting the apical 5 mm part off using low speed cutting machine (ISOMET 1000, Buehler, Lake Bluff, IL, USA). The middle portion specimen with 5 mm height was evaluated. Two coats of nail varnish

were applied to the external surface except the coronal end of post which was exposed to dye penetration. The teeth were then stored in 15% methylene blue for 2 hours (Figure 5).

Fig. 5. Prepared specimen before immerse in 15% methylene blue.



Dye penetration distance was evaluated by splitting the specimen vertically using low speed cutting machine (ISOMET 1000, Buehler, Lake Bluff, IL, USA) and measuring the distance using streomicroscope (Meiji Techno Co, Ltd., Japan) at 25X magnification and Pixera software (Pixera version 2.6.1, Pixera, CA, USA) (Figure 6).

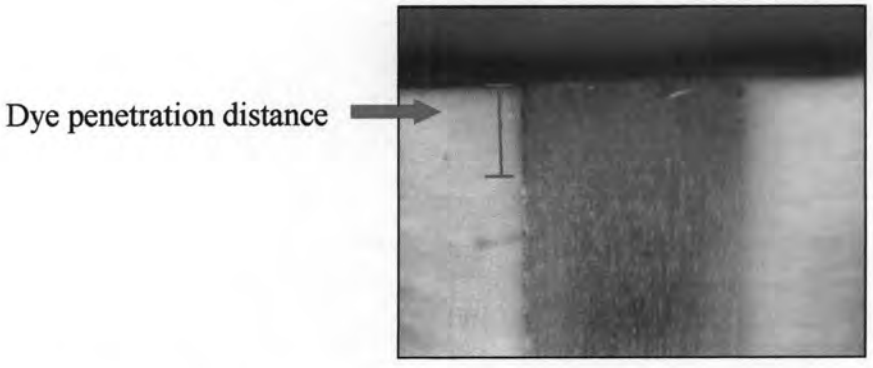


Fig. 6. Dye penetration distance evaluation.

Statistical analysis

The push out bond strength

The push out bond strength was analyzed using two-way ANOVA to detect the effect of the two main factors (luting cement and cyclic loading) and its interaction. Statistical significance was set at the 0.05 probability level.

Microleakage

The microleakage was analyzed using two-way ANOVA to detect the effect of the two main factors (luting cement and cyclic loading) and its interaction. Statistical significance was set at the 0.05 probability level.