

CHAPTER III

MATERIAL AND METHODS

Tooth preparation

Thirty two caries and restoration-free human maxillary central incisors similar in size, with straight roots and a single pulp canal extracted for periodontal reasons were selected for this study. The teeth were decoronated leaving root lengths of 15 ± 1 mm in group 1 & 2 and 13 ± 1 mm in group 3 & 4. Ferrule 2 mm were prepared on the teeth in groups 1 and 2. The teeth were divided into 4 groups based on the presence or absence of ferrule and post diameters used: group 1: ferrule + post fit, group 2: ferrule + smaller post, group 3: no ferrule + post fit and group 4: no ferrule + smaller post. (Table II)

Table II Differences in remaining tooth structure and post diameter in 4 groups

	Remaining tooth structure	Post diameter
Group 1 (n=8)	2 mm ferrule	Properly fit
Group 2 (n=8)	2 mm ferrule	Smaller post
Group 3 (n=8)	No ferrule	Properly fit
Group 4 (n=8)	No ferrule	Smaller post

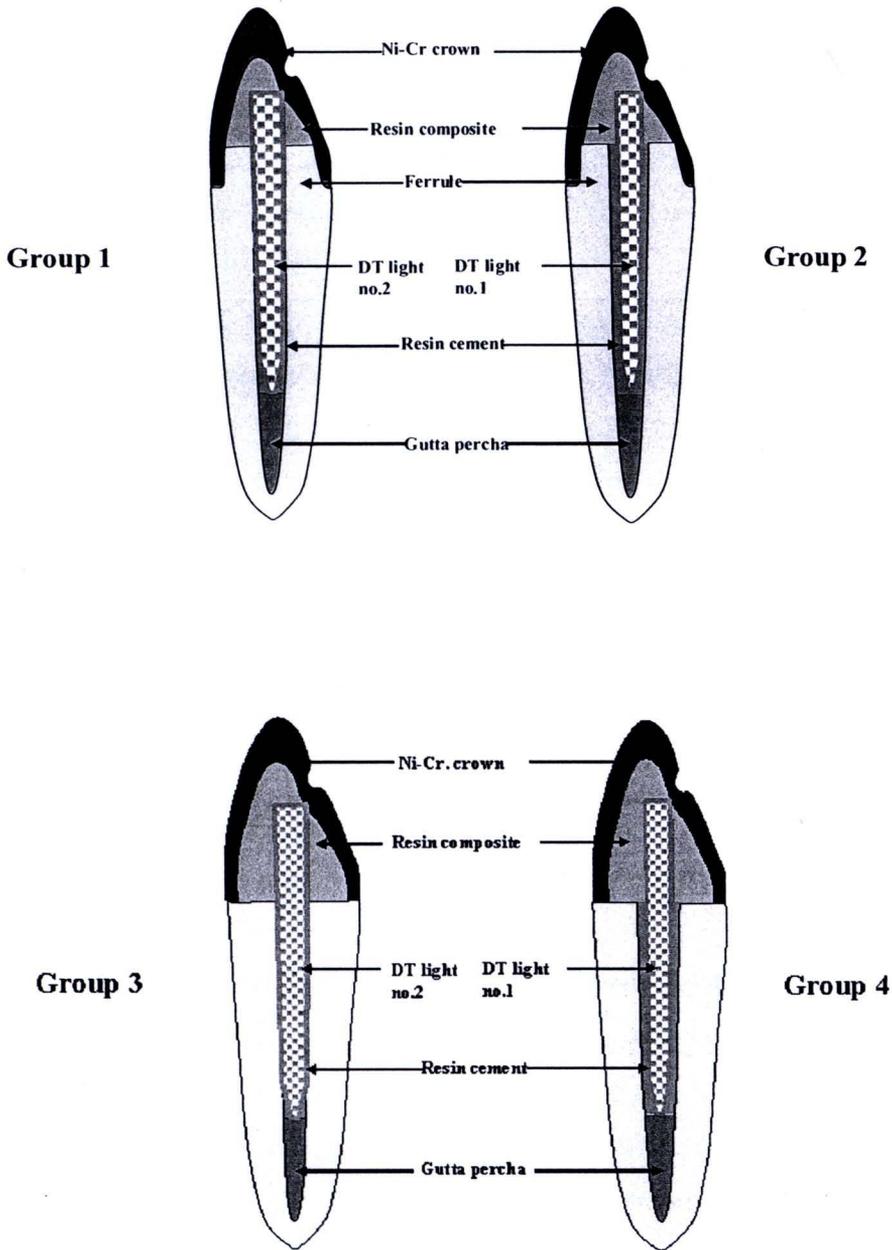


Fig. 5 Schematic drawing of 4 groups of tooth specimens with differences in ferrule and post diameters



Canal preparation

Root canal treatments were performed for all teeth using a step back technique until final instrument with a no.45 master apical file (K-file SybronEndo, SybronEndo Company, California USA). During preparation, the canals were irrigated with 5 ml of 2.5 % sodium hypochlorite and final irrigations were performed with 10 ml of 0.9% normal saline. The canals were dried with compressed air and paper points (CU Product, Chulalongkorn University, Bangkok, Thailand). Root canals were obturated by the lateral condensation technique with main cone and accessory gutta percha points (Hygenic Guttapercha Points, Coltène/Whaledent Inc., Ohio, USA), and root canal sealer (CU Product, Chulalongkorn University, Bangkok, Thailand). The extracoronary excess of gutta percha was removed and vertical condensation was performed with a heated condenser. The pulp chambers were sealed with a provisional restoration (Cavit, 3M ESPE, Seefeld, Germany).

Post space preparation and post cementation

The specimens were randomly divided into 4 groups (Table 1). Post spaces were prepared to a depth of 10 mm in ferrule groups and 8 mm in no ferrule groups with No.2 DT light post drill (Bisco Inc, Lançon De Provence, France) which has a double-taper design providing for proper post adaptation leaving 5 mm of gutta percha for apical seal. In groups 1 and 3, a DT light post no.2 was used. First, the root canal surface was prepared with self-etching primer (ED PRIMER II A&B, Kuraray medical, Okayama, Japan) for 30 seconds, and dried with paper points. The post was applied with silane coupling agent (mixture of Clearfil SE bond primer and porcelain bond activator, Kuraray medical, Okayama, Japan) for 5 sec to treat the post surface. Then, the post was coated with resin cement (Panavia F 2.0, Kuraray medical, Okayama, Japan) and introduced into canal with a pumping and rotating motion. Excess cement was removed and light cured with a light curing unit (Elipar Trilight 3M ESPE, Minnesota, USA) for 20 seconds, and complete polymerization of the cement was accomplished after 6 minutes. An oxygen barrier (Oxyguard II gel, Kuraray dental, Okayama, Japan) was

applied to the superficial margins for 3 minutes and then removed with cotton rolls and water spray.

In group 2 and 4, DT light post no.1 was used. Post preparation and cementation were the same as group 1 and 3.

Core build-up and crown cementation

A core build-up with resin composite to 5 mm in height was performed by using a total etch bonding technique. The tooth structure was conditioned with 37% phosphoric acid gel (Total Etch, Ivoclar Vivadent, Schaan, Liechtenstein) for 30 seconds on the enamel and then applied for 15 seconds to dentin, rinsed under water spray for 10 seconds, and dried with compressed air. Dentin bonding agent (Excite, Ivoclar Vivadent, Schaan, Liechtenstein) was applied for 10 seconds until glossy, then gently applied with compressed air for 5 seconds. Light polymerization was performed for 20 seconds with a halogen light. A 2 mm thick layer of resin composite (Tetric N Ceram, Ivoclar Vivadent, Schaan, Liechtenstein) was applied around the post, and light cured for 20 seconds. The incremental build-up core was performed until the desired shape was obtained using a silicone index and light cured 40 seconds for complete polymerization. The core was refined with a tapered flat-end diamond bur (ISO 314197, Intensiv, Switzerland) under water spray to creating a 1.5 mm labial reduction with shoulder finishing line and 0.5 mm lingual reduction with chamfer finishing line. An impression was made using polyvinyl siloxane impression material (Reprosil putty and light body consistency, Dentsply/Caulk, Milford, USA), and then poured with type IV dental stone (Vel-Mix, Kerr Corporation, California, USA). Next, the crown pattern was made with casting wax (blue inlay casting wax, Kerr, USA), and casted as a Nickel-Chromium crown (4all, Ivoclar Vivadent Williams #0123, USA). The crowns were finished and polished before evaluating their fit on the die. The crowns were tried on the prepared teeth and checked with explorer and fit checker (Fit checker, GC Corporation, Tokyo, Japan) under visual inspection. All crowns were cemented with resin cement (Panavia F 2.0) following the manufacturer instruction by using constant finger pressure applied for 40 seconds then the excess cement was

removed and protected with oxygen guard for 3 minutes. The specimens were stored for 7 days for a complete cement polymerization.

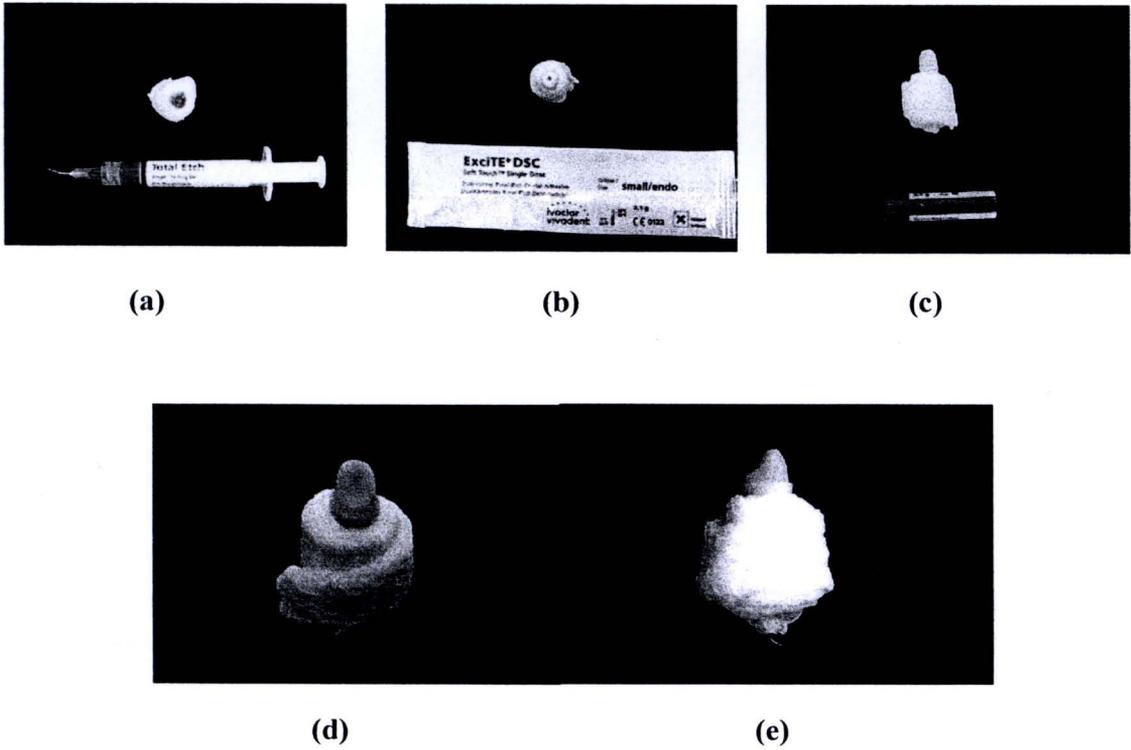
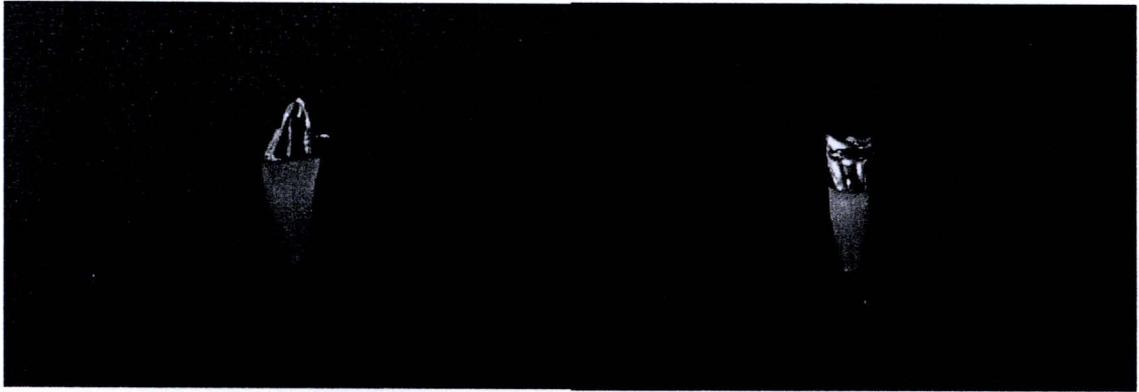


Fig. 6 Core build-up procedure (a) acid etching with 37% phosphoric acid (b) dentin conditioning with primer bonding agent (c) core build-up with resin composite (d,e) The core was preparation to form 1.5 mm labial reduction with shoulder finishing line and 0.5 mm lingual reduction with chamfer finishing line



(a)

(b)

Fig. 7 Specimen with crown cementation

Block preparation and periodontal ligament simulation

To simulate the periodontal ligament, the tooth roots were immersed in melted pink wax to produce a 0.2 mm layer of the average thickness of the periodontal ligament (7, 27), to a depth 2 mm below the cervical margin approximating biologic width. The specimens were mounted in PVC cylinders (22 mm in diameter and 20 mm in height) using self-cured acrylic resin (Formatray, Kerr, USA). Each tooth was removed from the resin block after the dough stage of self cured acrylic polymerization to prevent wax melting. After polymerization was complete, the tooth was replaced in the block and a silicone index of the crown to the resin block was prepared to ensure accurate repositioning. The wax spacer was removed from the root surface. Polyvinyl siloxane impression materials (Reprosil putty consistency, Dentsply/Caulk, Milford, USA) was injected into the acrylic resin block, then the tooth was repositioned into the block using prepared silicone index. Excess silicone material was removed with a scalpel blade to provide a flat surface 2 mm below the crown margin. Then, the specimens were stored in 37 °C for 7 days to ensure a complete polymerization of the resin cement (37)



Fig. 8 Specimen for fracture resistance test

Fracture resistance test

The fracture resistance test was performed by using a universal testing machine (Instron universal testing machine model 8872; Instron Co., Canton, Massachusetts, USA). The compressive load was applied onto a prepared notch of the lingual surface (4 mm from the crown margin) at a 135-degree angle from tooth axis with a crosshead speed of 1 mm/min (19) until failure occurred. Fracture force was recorded in Newton (N). Data were analyzed by statistical software (SPSS Statistics version 17.0, SPSS Inc, Illinois, USA) using two-way ANOVA to evaluate the interaction between the effect of ferrule and post diameter. One-way ANOVA and Tukey HSD multiple comparisons post-hoc analyses ($\alpha < 0.05$) were used to analyze significant differences between groups at 95% confidential interval. Subsequently, the mode of failure of each specimen was examined by visual inspection under the stereomicroscope (EOS 100, Canon, Japan).

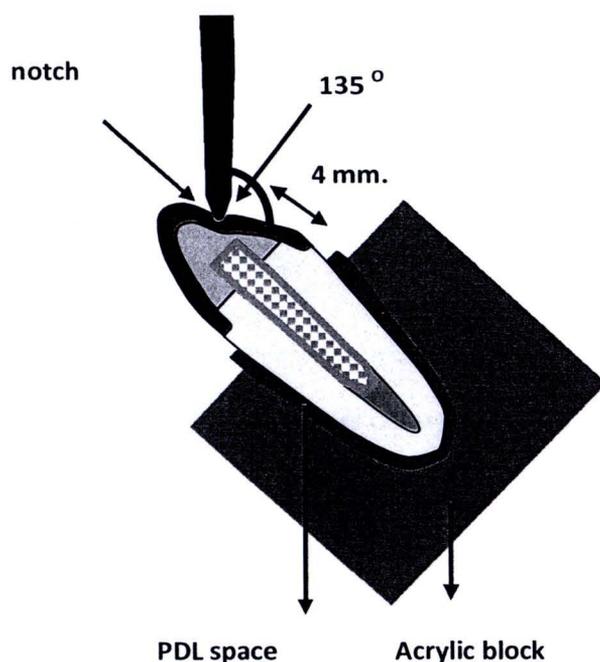


Fig. 9 Schematic drawing of specimen for fracture resistance testing