Introduction

One of the major goals of root canal treatment is to seal the root canal system three dimensionally and eliminate microorganisms localized in root canal systems to prevent reinfection by completely filling the canals with stable materials. A satisfactory seal cannot be obtained without the use of a sealer in combination with gutta-percha to achieve fluid impervious apical seal. An ideal root canal sealer should be biocompatible, antibacterial, nontoxic, radiopaque, should also hermetically seal the root canal system, be dimensionally stable, and should have good adhesion to the root canal wall.

Adhesion is desirable physical-chemical property of root canal sealers. Recently, adhesive obturation systems have been introduced in endodontics in an attempt to obtain a "monoblock" in which the core material, sealing agent and root canal dentin form a single cohesive unit within the root canal [(1)] Increased adhesive properties to dentin might lead to greater strength of the restored tooth, which may provide greater resistance to root fracture and clinical longevity of an endodontically treated tooth[(2)] Recent advances in adhesive technology have led to the introduction of a new generation of endodontic sealers and filling materials that are based on adhesive properties and polymer resin technology.

Elimination of microorganisms from the root canal is always considered an important part of endodontic therapy. Biomechanical instrumentation, irrigation, and intracanal medication may reduce significantly the population of microorganisms in an infected root canal. However, studies reported in the literature have proved the presence of bacteria in dentinal tubules and cementum even after treatment[3] For this reason, particularly when pulpal necrosis and apical periodontitis are present, the choice of a sealer with high antimicrobial activity helps to decrease or avoid growth of these remaining microorganisms

Several root canal sealers have been used in endodontic, from zinc oxide euogenol based (ZOE) sealers to the resin based sealers, all of them proposed to be used in association with gutta-percha. Resin based sealers are classified into methacrylate based sealers and epoxy based sealers.

The methacrylate resin-based sealers have developed to adhere to the walls of the root canal through the formation of a hybrid layer, thereby reducing infiltration and increasing the seal between the root canal and the sealing material[4]. Metaseal soft sealer is methacrylate-based sealer containing 4-methacryloyloxyethyl trimellitate anhydride (4-META), 2-hydroxyethyl methacrylate (HEMA), and (difunctional

methacrylate monomers) as liquid, and the powder consist (zirconium oxide, silica, hydrophilic initiator).

Therefore, conducting a study to evaluate the shear bond strength and antimicrobial activity of (MetaSeal soft, AH plus, and Tubliseal) root canal sealers. Seems to be of great interest.

Review of Literature

Ideal endodontic sealer should seal the root canal space and should adhere to both the gutta-percha core and root canal wall, and should have good antimicrobial activity to kill and eliminate residual microorganisms.

Shear bond strength:

Osorio et al (2002)[5] evaluated the effect of sodium hypochlorite (NaOCI) treatment on dentin bonding by means of contact angle (CA), shear bond strength (SBS), and microleakage (ML) measurements. Ultrastructure and nanoleakage (NL) of the interface were examined by transmission electron microscopy (TEM). The results showed that CA values decreased after acid etching and even more after NaOCI treatment. NaOCI treatment produced lower SBS than acid-etched dentin. Both ML values and NL manifestations were similar for NaOCI-treated and acid-etched dentin. NL was manifested along the base of hybrid layers and within the polyalkenoic acid copolymer in both groups. Adverse chemical interactions could have occurred between the remnant collagen matrix and/or mineralized dentin after NaOCI treatment.

Gogos et al (2003)[6] compared the bond strength of AH-26 root canal sealer to human root canal dentine exposed to different intracanal medications both with and without the use of three bonding agents. The materials used were AH-26 sealer, two one-bottle bonding agents (Single Bond, Bond-1) and one self-etching bonding agent (Clearfill SB Bond).

The dentine substrate was obtained from single rooted human teeth. The dentine specimens were treated either with EDT'A 1.5% or phosphoric acid 37% to achieve the removal of smear layer. The AH-26 sealer was placed on the dentine surfaces both with and without the use of the bonding agents. Bond strength was tested using a single plane shear test assembly. The SBS values were (MPa):GroupA(EDTA--AH-26)3.678±.853. Group B (Phosphoric acid- AH-26) 3.4703:0.834. Group C (EDTA~Single-Bond-AH-26) 4.8±0.865. Group D (Phosphoric acid-Single Bond-AH-26) 5.043±1.022. Group E (EDTA-Bond 1AH-26) 4.939±0.877. Group F (Phosphoric acid-Bond 1-AH-26) 5.10ldtl.137. Group G (Clearfill SE Bond-AII-26) 6.9753=1.694. The use of dentine bonding agents improved significantly the adhesion of AH-26 sealer with the root canal dentine. However, the best results were obtained with the self-etching system. Similar results were observed from the pretreatment of dentine either with phosphoric acid 35% or EDTA 15%. The use of dentine bonding agents gave higher shear bond strength of AH-26 sealer to human root canal dentine.

Eldenize et al (2005) [7] evaluated the shear bond strength of three endodontic sealers (Diaket, AH plus, EndoREZ). The coronal two thirds of ninety extracted human third molars were removed. The smear layer of exposed dentine surfaces were removed using 17% EDTA followed by 5.25% NaOCL and the teeth were randomly divided into two groups (n =45). Group 1 was kept as control and in group 2; uniform smear layer was created using waterproof polishing papers. Three- mm long sections of polyethylene tubing were filled with freshly mixed sealer and placed

on the dentine surfaces for conducting a shear bond strength test. Results showed that the AH plus sealer showed the highest bond strength in smear layer removed surfaces ($p < 0.05$). Pretreatment with EDTA/NaOCL affected bond strength of AH plus. AH plus had the highest bond to dentine with or without smear layer.

Hiraishi et al (2005)[8] evaluated the adhesive strength of Resilon to next root canal sealant (Heraeus-Kulzer), a methacrylate-based root canal sealer, using a modified microshear bond testing design. Flat Resilon surfaces of different roughnesses were prepared by compression moulding for bonding to the sealer and compared with a composite control. After shear testing, fractured specimens were examined using a field emission-scanning electron microscope for detailed analysis of the failure modes. The composite control exhibited significantly higher mean shear strength (7.62 MPa) that was 4.4-4,7 times those of the Resilon groups (1.64- 1.74 MPa; P 0.05). Failure modes in the composite control were cohesive and mixed failures, while those in the Resilon groups were predominantly adhesive failures, with a small percentage of mixed failures. Ultrastructural evidence of phase separation of polymeric components could be identified in Resilon. The low shear strength of Resilon to a methacrylate-based sealer compared with a composite control suggests that the amount of dimethacrylate incorporated in this filled, polycaprolactone-based thermoplastic composite may not

yet be optimized for effective chemical coupling to methacrylate resins.

Gesi et al (2005) [9] evaluated the interfacial strength of Resilon and gutta percha to intraradicular dentin. They compared the interfacial strengths of Resilon/Epiphany and gutta-percha/AH Plus using a thin-slice push-out test design, failure modes of root slices after push-out testing were examined with environmental scanning electron microscopy. The gutta-percha group exhibited significantly higher interfacial strength than the Resilon group. The Resilon root slices failed predominantly along the sealer/dentin interface with recognizable, fractured resin tags. Detachment of the Resilon from the Epiphany sealer was also surprisingly observed in some specimens. The similarly low interfacial strengths achieved with both types of root filling challenges the concept of strengthening root Hi led teeth with the new endodontic materials.

Tay et al (2006) [10] evaluated the bondability of Resilon to a methacrylate-based root canal sealer (RealSeal). The adhesive strength of Resilon was evaluated using a modified microshear bond testing design. Results showed that, composite control exhibited mean shear strength 7.3 to 26.9 times higher than those of the Resilon groups. Shear strength differences among the Resilon groups of different surface roughness highlighted the contribution of micromechanical versus chemical coupling in sealer retention.

Sly et al (2007) [11] evaluated the push-out bond strength of two different endodontic obturation systems (Epiphany/Resilon system and gutta-percha/AH 26). Differences in push-out bond strength between the two different material systems were obtained using repeated measures analysis of variance on ranks. Results showed that, gutta-percha had significantly higher push-out bond strength than Epiphany.

Skidmore et al (2006) [12] compared the micropush-out bond strength of Resilon to that of gutta-percha. The specimens were randomly divided into two groups. Gutta-percha group: obturation with gutta-percha and Kerr Pulp Canal Scaler EWT. Resilon group; obturation with Resilon points, Epiphany Primer, and root canal sealant. Micropush-out bond strengths to root canal dentin were measured. Results showed that the mean bond strength to-root canal dentin was significantly higher in theResi 1 on/Epiphany group as compared to the gutta- perch a/Kerr Pulp Canal Sealer EWT group.

Wachlarowicz et al (2007) [13] examined the effects of commonly employed endodontic irrigants on Epiphany-dentin bond strengths. Smear layers were created on dentin discs obtained from human third molars. Five groups of 10 discs each were treated with one of the following: (a) water; (b) 2% chlorhexidine; (c) 6% sodium hypochlorite (NaOCI); (d) 6% NaOCI followed by EDTA and water; or (e) 1.3% NaOCI followed by MTAD. The treated

surfaces were air-dried and treated with Epiphany primer. Hollow steel tubes were placed on the dentin surfaces, and Epiphany sealer was applied to dentin inside the tubes. Samples were tested for shear bond strengths after 7 days of storage. Representative specimens were examined using scanning electron microscopy. Using water or chlorhexidine as an irrigant resulted in significantly lower bond strength when compared with NaOCI, NaOCI/EDTA, or NaOCI/MTAD. Neither EDTA nor MTAD significantly improved Epiphany-dentin bond strengths when compared with NaOCI used alone.

Mathew et al (2008) [(14)] evaluated the bond strength of eugenol and noneugenol based endodontic sealers to gutta-percha and dentin, to make a comparative evaluation of the bond strength of sealers to guttapercha and dentin, used Seventy two specimens which was divided into two groups group I consisting of 36 freshly extracted human molars with 2 mm coronal cut surface; and group II consisting of gutta-percha disks of 10 mm diameter and 2 mm thickness embedded in 36 plaster of Paris specimens. Group I was further divided into three subgroups: subgroup 1, subgroup 2, and subgroup 3, consisting of 12 teeth each; and group II was further divided into three subgroups: subgroup 1, subgroup 2, and subgroup 3, consisting of 12 plaster specimens. Each subgroup consisted of two materials each, which were placed in 5 mm long sections of polyethylene tubing and were then placed on coronal 2 mm cut

surface of human molars; likewise subgroup 1, subgroup 2, and subgroup 3 of group II consisted of two materials each, which were also placed in 5 mm long sections of polyethylene tubing and then placed on gutta-percha disks 10 mm in diameter and 2 mm in thickness, which were embedded in the plaster specimens. After the materials were set, the specimens were subjected to test for shearing bond strength using a universal testing machine. The result s showed that the Group I, i.e., zinc oxide eugenol sealers, showed more bond to gutta-percha than to dentin, in which subgroup 2b, endomethasone, showed the maximum bond. Group II, i.e., non-zinc oxide eugenol sealers, showed more bond to dentin than to gutta-percha, where the maximum bond was shown by subgroup 3b, EndoRez.

Teixeira et al (2009) [15] evaluated the adhesion of root canal filling materials. Three groups were established (n=7). Group 1, root cylinders obtained from human canines were embedded in acrylic resin and had their canals prepared and filled with sealer. Group 2, longitudinal sections of dentin cylinders were embedded in resin with the canal surface smoothed and turned upwards. Group 3, gutta-percha cylinders were embedded in resin. Polyethylene tubes filled with sealer were positioned on the polished surfaces of the specimens (groups 2 and 3). The push-out test (group 1) and the SBS test (groups 2 and 3) were performed in an Instron universal testing machine. Statistical

analysis by ANOVA and Student's t-test (alpha-0.05) revealed statistically significant differences among the groups. SEM analysis showed a predominance of adhesive and mixed failures of AH Plus sealer. The tested surface affected significantly the results with the sealer reaching higher bond strength to dentin than to gutta-percha with the SBS test.

Ayad et al (2010) [16] examined the effects of varied dilutions of lactic acid as a root canal irrigant and compared the shear bond strength of Epiphany adhesive sealer to human dentin surface with other solutions suitable as root canal irrigants. The occlusal surfaces of 60 extracted molar teeth were ground wet and treated with one of the following irrigants: 1) no irrigant (control); 2) 5% hydrogen peroxide; 3) 5% sodium hypochlorite; 4) 15%EDTA; 5) 10% lactic acid; or 20% lactic acid. An additional specimen for each group was critical-point dried and freeze-fractured to evaluate the dentin surfaces after treatment by scanning electron microscopy. Specimens were treated with Epiphany primer, hollow steel tubes were placed on the dentin surfaces, and resin sealer (Epiphany) was applied to dentin inside the tubes. Specimens were stored in 100% humidity, then loaded to failure in a universal testing machine in the shear mode with a cross speed of 0.05 mm/min. Dentin surface treatment resulted in significant differences for surface topography and shear bond strength of Epiphany sealer. Lactic acid and EDTA significantly

improved epiphany- dentin bond strengths when compared with other irrigants. The highest mean (SD) bond strength was 1.95 (0.47) MPa for dentin surfaces treated with 20% lactic acid. The lowest mean bond strength [0.41 (0.29) MPa] was associated with untreated dentin surfaces.

Kandaswamy et al (2011) [17] evaluated the effect of strong (MTAD) or soft (1- hydroxyethylidene – 1, 1-bisphosphonate (HEBP) final irrigating solution on the shear bond strength of AH plus sealer to coronal dentin. 17% EDTA was used as the reference .Used Forty freshly extracted human maxillary first premolars were prepared using different irrigation protocols (n=10). All the test groups had 1.3% NaOCl as initial rinse and followed by specific final rinse for each group: G1 – distilled water(control), G2 – 17% EDTA, G3- 18% HEBP and G4 – MTAD. Sections of polyethylene tubes that are 3mm long were filled with freshly mixed sealer and placed on the dentin surfaces. The bonding between the sealer and dentine surface was evaluated using shear bond testing. Results showed that significant difference was found among the irrigating regimes. EDTA showed highest bond strength followed by HEBP and MTAD.

Gopikrishna et al (2011) [18] evaluated the effect of MTAD in comparison with EDTA as a final rinse on the shear bond strength of Kerr, Apexit, and AH plus. Dentine surfaces of 135 extracted human non-carious maxillary premolars were divided into three groups

(n=45). Groups I and II were conditioned with 1.3% NaOCL for 20 min, followed by final rinse of 17% EDTA for 1 min and MTAD for 5 min respectively . Group III was treated with distilled water. Each group was further divided into three subgroups (n=15). Subgroup 1: Kerr, subgroup 2: Apexit, and subgroup3: AH plus. Three millimeter- long sections of polyethylene tubes were filled with freshly mixed sealer and placed on the dentin surfaces. The bonding between the sealer and the dentin surface was evaluated using shear bond testing. Significant difference was found among the bond strength of the sealers and irrigating regimes. AH plus showed superior bond strength among the tested sealers, when EDTA was employed as the final rinse ($P<0.05$). MTAD as a final rinse affected the bond strength of AH plus and Apexit, which were significantly lower than the control group.

Barbizam et al (2011) [19] evaluated the bond strength of different root canal sealers to dentin. Used forty extracted single – rooted human teeth were examined and the coronal and middle thirds of the canals were prepared with a 1.50 mm post drill (Fibrekor post system, pentron). The teeth were allocated in two experimental groups, irrigated with 2.5% NaOCL + 17% EDTA or saline solution (control group) and instrumented using Race rotary files (FKG) to a size 40 at the working length. Then, the groups were divided into four subgroups and filled with Epiphany sealer (group 1),EndoREZ (group 2), AH26(group 3), and

Grossman sealer (gruop4). After two weeks of storage in 100% humidity at 37C, all teeth were sectioned transversally into 2-mm-thick discs. Push-out tests were performed at a cross-head speed of 1 mm/min using a universal testing machine. The maximum load at failure was recorded and expressed in MPa. Results showed that the highest bond strength for the Epiphany group ($p < 0.01$) when compared to the other tested sealers. Saline solution decreased the value of bond strength ($p < 0.05$) for all sealers. And the use of 2.5% NaOCL and 17% EDTA increased the bond strength values for all sealers.

Vilanova et al (2012)[20] evaluated the bond strength of Epiphany and AH Plus sealers to root canal walls using a push-out test after use of several endodontic irrigants. Used Roots of 100 maxillary canines were sectioned horizontally 5mm below the cemento-enamel junction to provide 4-mm-thick dentine disks that were embedded in acrylic resin and had their root canals prepared with a tapered bur . The specimens were randomly assigned to five groups (n=20) according to the dentine surface treatment: I - 1% NaOCl (30 min); II - 1% NaOCl (30 min) + 17% EDTA (5 min); III - 17% EDTA (30 min); IV - 24% EDTA gel (30 min); V - 2% chlorhexidine gluconate (CHX) gel (30 min). In each group, two specimens were prepared for scanning electron microscopy to examine the surface of root canal dentine after use of each irrigant. The other 18 specimens were filled with AH plus (n=9)

or Epiphany (n=9) and subjected to a push-out test in an Instron machine. results showed AH Plus had a significantly higher bond strength than Epiphany .One percent NaOCl/17% EDTA was associated with significantly higher bond strength values than the other irrigants (P <0.05). Seventeen per cent EDTA, 24% EDTA gel and 2% CHX gel had intermediate values that were not significantly different from each other (P > 0.05). One per cent NaOCl was associated with the lowest mean values. The interaction between surface treatment and sealer revealed significantly higher bond strength for 24% EDTA gel with AH Plus, 2% CHX gel with AH Plus and 1%NaOCl/17%EDTA with Epiphany (P < 0.05). So, Exceptfor1%NaOCl,the removal of smear layer with the other irrigants increased the bond strength of AH Plus to intracanal dentine. The use of 1% NaOCl for 30min with 17% EDTA as final irrigant for 5 min increased the bond strength of Epiphany

Rocha et al (2012) [21]. evaluated the influence of 2% chlorhexidine and 2.5% sodium hypochlorite on the resin sealer/dentin interface bond strength of AH plus / gutta-percha and Epiphany /resilon. Seventy-two extracted bovine incisors were randomly distributed into 6 groups according to irrigant and sealers: G(S+AH)=physiologic saline solution+AH Plus/gutta-percha; G(S+Ep)=physiologic saline solution + Epiphany/ Resilon; G (H+ AH)= 2.5% sodium hypochlorite (NaOCl) + AH Plus/ gutta-percha; G (H+Ep)=2.5% NaOCl+ Epiphany/ Resilon; G (C+AH)=2%