

## Evaluation of Sealing Ability of Three Different Root Canal Sealers (in Vitro Study)

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**Abstract: Aim:** *The aim of this study was to evaluate the apical sealing ability of three different endodontic sealers using dye penetration method.*

**Materials and Methods:** *Palatal roots of forty five extracted maxillary first molars were instrumented with ProTaper rotary files to size F4. The teeth were divided into three experimental groups according to type of sealer used, **group1:** root obturated with AH Plus sealer and single cone technique, **group2:** root obturated with ActiV GP sealer and single cone technique, **group3:** root obturated with GuttaFlow2 sealer and single cone technique. Data was subjected to statistical analysis. P-Value<0.05 was considered as significant.*

**Results:** *The results of this study showed that Gutta-Percha/AHPlus showed the lowest mean of leakage.*

*There was statistically difference between Gutta-*

*Percha/AHPlus and the two contemporary single  
cone techniques ActiV GP and GuttaFlow2*

*Conclusion: AH Plus showed the least leakage  
compared to ActiV GP and GuttaFlow2.*

*Keywords: apical sealing, dye penetration, endodontic  
sealers, single cone technique.*

### **Introduction:**

The complete obturation of the root canal system by using filling materials with adequate biological and physicochemical properties is one of the main goals of root canal treatment. The filling techniques which are most often applied involve the use of gutta-percha cones and an endodontic sealer [1].

A great variety of endodontic sealers are available commercially, and they are divided into groups according to their chemical composition. There are sealers based on zinc oxide and eugenol, epoxy resin, calcium hydroxide and glass ionomer [1]. Among the current resin-based sealers, the AH Plus epoxy-amineresin-based sealer (Dentsply Maillefer, Ballaigues, Switzerland) is the most commonly used because of its good physical and chemical properties and good sealing ability. However, with the aim of improving the marginal sealing properties of endodontic sealers, new sealers have been developed [2]. Due to a desire to obtain an ideal filling material, GuttaFlow2 (Coltène Whaledent, Altstätten, Switzerland) has been introduced with the idea of combining a large amount of solid material (gutta-percha powder) and a polydimethylsiloxane-based sealer into the same product.

This new product is biocompatible and its physical, chemical and sealing properties make it suitable to this task, since it is similar to its predecessor [3]. Pitt Ford in 1979 [4] introduced a glass-ionomer (GI) sealer in a single-cone technique. It is the only self-adhesive material currently available that eliminates the need for a separate adhesive system. Glass ionomer adheres to dentin through physical and chemical interaction; physical interaction is through a

micromechanical interlocking of the material to tooth surface irregularities, while chemical interaction occurs when polyacrylate ions of GIC displace existing phosphate ions in the hydroxyapatite crystal and attached to dentin[5]. Activ GP has 2  $\mu\text{m}$  coating of GI particle in its surface; these particles are also incorporated into the body of the cone. Activ GP gives the advantage of monobloc obturation (true single cone technique), and glass ionomer cements (biocompatibility, adhesion, fluoride release and antimicrobial activity) [6]. To study the sealing property of new filling materials and techniques, several methods have been used: dye [7], fluid transport [8], [9] and glucose penetration [10].

The aim of this study was to compare the sealing ability of different root canal sealers

### **Materials and Methods:**

Forty five freshly extracted maxillary first molars teeth with straight palatal root were selected from different health centers for this study according to specific criteria. After extraction, all teeth were stored in 0.1% thymol solution at room temperature. The roots surfaces were verified with a magnifying eye lens (10X) and light cure device for any visible cracks or fractures. Using diamond disc mounted on straight hand-piece and under water coolant the palatal root of teeth was sectioned perpendicular to the long axis of the root at the furcation area to facilitate straight line access for canal instrumentation and filling procedure.

The length of the root was determined by digital caliper and marker to (10) mm from apex to cement-enamel junction. The exact location of the apical foramen and the patency of the canals were verified by insertion of a No.15 K-file into the canal and advancing until it is visualized at the apical foramen.

The canals were instrumented using rotary ProTaper instruments were used according to the manufacturer's instructions using (Endo-Mate motor) at constant speed 300 rpm (1.4Ncm). The instrumentation was completed in crown down manner using gentle in and out motion. The canals were instrumented to MAF # F4/.06.

During instrumentation procedures, 2 ml of 2% NaOCl solution was used before each file. All specimens received a final flush of 2 ml of 17% EDTA for 3 min and 5 ml of saline solution. Then the root canals were dried with sterile paper points (Dentsply Maillefer). The prepared teeth were randomly divided into three groups of 15 teeth each. All teeth were obturated following manufacture's instruction using single cone technique.

**Group (1):** In this group, the AH Plus sealer (Dentsply, Germany) mixed according to the manufacturer's instructions. The tip of master cone #40/.06 was coated with the AH plus sealer and placed into canal to full working length.

**Group (2):** Canals were obturated with Activ GP root canal obturation system (Brasseler USA, Savannah). After the root canals were dried with master paper points, Activ GP sealer powder and liquid in (3:1) ratio mixed following the manufacturer's instructions. Then the apical half of Activ GP master cone #40/.06 was coated with sealer and inserted slowly in the canal with circular motion until it reach full working length.

**Group (3):** Canals were obturated with #40/.06 gutta-percha and GuttaFlow2 sealer (Coltene, Germany) according to the manufacturer's instructions. GuttaFlow®2 was spread on a mixing slab and inserted into the root canal with the master file #40, the gutta-percha cone was placed into the root canal. Then the master cone #40/.06 coated with sealer and inserted to the working length.

For all groups excess gutta-percha was removed with hot plugger 1mm below the orifice. All obturated roots of all groups were wrapped in saline moistened gauze in closed plastic vial allowing the sealer to set for 1 month at 37°C in an incubator [9], then the experimental root surfaces except the apical 2 mm were covered with one layer of nail varnish and two coats of sticky wax. The teeth were then immersed in India ink (Pelikan, Hannover, Germany) for 7 days [12].

After removal from the dye, the teeth were washed under running tap water and the sticky wax was scraped from the root surface with a lacron carver and washed again under running water [12]. Demineralization and clearing process was completed as

described by Al-Hashimi [13]. The teeth were demineralized in 5 % nitric acid solution and dehydrated in 99-100% ethyl alcohol for 3 days with daily change of alcohol. The clearing process was completed by immersing the teeth in methyl salicylate solution. The extent of dye penetration was measured by two observers using a Stereomicroscope (Kruss, Germany) in millimeters. The measurements were made from the most apical extent of gutta-percha to the most coronal extent of dye penetration. The data were analyzed statistically using ANOVA and Least significant difference test (LSD) test [14].

## Results

For the microleakage parameter the results of this study showed that group 1 (AH Plus) have the lowest mean value of dye penetration (0.23mm) while the highest mean value of dye penetration showed by group 2 (Activ GP) (0.41mm). The rest value for the 3rd group (GuttaFlow2) was fluctuation between these values (0.35mm). Analysis of variance (ANOVA) test was performed and showed that there were very highly significant differences ( $p \leq 0.001$ ), LSD test showed that there were very highly significant differences ( $p \leq 0.001$ ), between group 1&2 and for 1&3 while there is no significant difference ( $P \geq 0.05$ ) between 2&3.

## Discussion

Complete obturation of the root canal system with an impervious, biocompatible and dimensionally stable filling material is essential for successful root canal treatment. However, it has been reported that a complete seal of the root canal system is almost impossible with currently accepted materials and obturation techniques using a combination of gutta-percha and root canal sealer [15]. Ideally, the root canal sealer should be capable of producing a bond between the core material and the root dentine, effectively preventing leakage [15].

Three dimensional sealing of the root canal is one of the main goals of endodontic treatment and is essential for preventing reinfection of the canal and for preserving the health of periapical tissues, thereby ensuring the success of root canal treatment. Thus, several types of endodontic sealers have been recommended to achieve this goal and consequently, evaluation of the apical sealing ability of sealers is important. Therefore in the present study, the apical sealing ability of three root canal sealers was evaluated [15].

AH Plus sealer showed the lowest leakage value compared to other sealers, AH Plus is a root canal sealer based on epoxy resin derived from AH 26, several authors have shown that AH Plus is the material that has the best sealing capacity [16][17][18]. Other investigations have further shown high-quality properties with epoxy resin-based sealers, including very low shrinkage while setting, long term dimensional stability, flow, and long setting time, AH Plus sealer penetrates deeper into the surface micro irregularities [19]. This agrees with the finding of Monticelli et al. 2007 [20].

A highly significant difference was shown between AH Plus group and the Activ GP group, like other self-curing, GI cements and resin composites, may have undergone shrinkage during its setting phase creating gaps between the sealer and root dentin [20]. This result may be also attributed to the non homogeneous mix of GI sealer which is questionable which might have an adverse effect on its properties.

The most probable explanation for low mean leakage in GuttaFlow2 would be the setting expansion of Guttaflow2 by 0.2% as claimed by manufacturers, and corroborated in studies [21][22][23]. The presence of small sized gutta percha particles (nano-particles less than 30 microns) further imparts increased flowability to Guttaflow2, resulting in better spreading capacity and adaptation to root canal walls, and into dentinal tubules [25], also implying decreased leakage.

There was no significant difference between Activ GP and GuttaFlow2 and this was in agreement with Monticelli et al. 2007 [20], Nikhil et al. 2012 [26].

## Conclusion

A root canal sealer is required to provide a seal between the core filling material and the canal wall. The resin-based root canal sealers like AH Plus showed significantly less leakage than other groups and has got better sealing ability compared to Activ GP, while Guttaflow2 sealer showed the highest apical leakage amongst all three groups tested.

Further studies with a larger sample size along with clinical trials, in different canal configuration are needed to evaluate the sealing ability of these sealers.

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*Table (1): Descriptive statistics for all experimental groups,  
(microleakage)*

	N	Mean	S.D	S. E	Min	Max
<b>Group</b>						
<b>1</b>	<b>15</b>	<b>0.2378</b>	<b>0.08156</b>	<b>0.02106</b>	<b>.15</b>	<b>.36</b>
<b>2</b>	<b>15</b>	<b>0.4113</b>	<b>0.05303</b>	<b>0.01369</b>	<b>.33</b>	<b>.50</b>
<b>3</b>	<b>15</b>	<b>0.3587</b>	<b>0.08484</b>	<b>0.02191</b>	<b>.25</b>	<b>.50</b>

*Table (2) ANOVA test among groups*

Source of Variation	Sum of Squares	df	Mean Square	F	P.value	Sig.
<b>Between Groups</b>	<b>.238</b>	<b>2</b>	<b>.076</b>	<b>21.390</b>	<b>.000</b>	<b>***</b>
<b>Within Groups</b>	<b>.233</b>	<b>27</b>	<b>.006</b>			
<b>Total</b>	<b>.471</b>	<b>29</b>				

\*\*\* Very highly significant

*Table (3) LSD test between groups*

Groups	P.value	Sig.
<b>1&amp;2</b>	<b>.000</b>	<b>***</b>
<b>1&amp;3</b>	<b>.000</b>	<b>***</b>
<b>2&amp;3</b>	<b>.060</b>	<b>N.S</b>

\*\*\* Very highly significant; N.S Non-significant difference.

## تقييم لقدرة الاحكام لثلاثة حشوات جذور طلائية – دراسة مختبرية

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### المستخلص:

الهدف من هذه الدراسة المختبرية كان لتقييم قدرة إحكام قمة الجذر لثلاثة حشوات جذور طلائية مختلفة باستخدام طريقة التخلل الصبغية. خمسة وأربعون جذر حنكي لأسنان مقلوعة وهي الضرس الأول من الفك العلوي تم تحضيرها بمبارد الحفر الآلي (بروتابر) إلى الحجم ف4. قسمت هذه الأسنان إلى ثلاثة مجموعات مختبرية وفقا لنوع حشوة الجذر الطلائية المستخدمة، حيث كانت المجموعة الأولى تمثل الجذور التي تم حشوها باستخدام (اي اتش بلاس)، و المجموعة الثانية تمثل الجذور التي تم حشوها باستخدام (اكتف جي بي)، والمجموعة الثالثة للجذور التي تم حشوها باستخدام (جوتا فلو 2) وكانت النتيجة أن (اي اتش بلاس) قد اظهر اقل معدل للتسرب مقارنة بكل من (اكتف جي بي) و (جوتا فلو2).

الكلمات الرئيسية: قدرة الاحكام لقمة الجذر، التخلل الصبغى، حشوات الجذور الطلائية، طريقة المخروط المفرد.