تقييم التوافق الحيوى وقدرة الغلق لنظام مستحدث ذى قاعدة راتنجية للغلق

رسالة مقدمة من

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توطئة للحصول على درجة الدكتوراة فى علاج الجذور

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أهداف الدراسة هى:

١. تقييم التوافق الحيوى وقدرة الغلق عند التاج وعند قمة الجذر وقوة الربط لنظام مستحدث ذى قاعدة راتنجية.
٢. تقييم هذا النظام المستحدث اكلينيكيا وباستخدام الأشعة.

تتكون الدراسة من ثلاثة أجزاء رئيسية:

١. الجزء الأول تضمن دراسة التوافق الحيوى حيث استخدمت عظام الأرانب لزرع المواد المختبرة. ثم تقييم التفاعل الحيوى بفحص الأنسجة الباثولوجى بعد كل من ثلاثة فترات هى : ثلاثة أيام ، أسبوع ، وستة أسابيع.

٢. أ ما قدرة الغلق فتم تقييمها بعدة طرق هى:

أ- دراسة الرشح:
استخدمت جذور أحادية القنوات و تم توسيعها واروائها باستخدام هيبوكلوريت الصوديوم والاديتا، ثم تم تجفيفها بورق نشاف.
بعد ذلك قسمت العينات الى مجموعتين رئيستين حسب مادة الحشو المستخدمة:
- قنوات تم حشوها بالجوتا بركا ولأسمنت اللاصق.
- قنوات تم حشوها بالرزيلون والابيفانى.

تم تقسيم كل من المجموعتين الرئيسيتين الى مجموعتين فرعيتين طبقا لطريقة الحشو، كالتالى:
١) قنوات تم حشوها باردا بالضغط الجانبى بالجوتا بركا والأسمنت اللاصق.
٢) قنوات تم حشوها بالضغط الرأسى مع التسخين بالجوتا بركا والأسمنت اللاصق.
٣) قنوات تم حشوها باردا بالضغط الجانبى بالرزيلون والابيفانى.
٤) قنوات تم حشوها بالضغط الرأسى مع التسخين بالرزيلون ولأبيفانى.

تم تقييم هذة المجموعات باستخدام نفاذية الصبغة وفحصها تحت المجهر . هذا الفحص استخدم لتقييم الرشح عند التاج وعند قمة الجذر.

ب- من جهة أخرى ، تم فحص هذة المجموعات تحت المجهر الالكترونى الماسح لدراسة السطح البينى بين مادة الحشو وسطح السنة.
ج- درست قوة الربط بين مادة الحشو الجديدة ابيفانى وعاج السنة باستخدام جهاز اللويد.

٣. وأخيرا تم تقييم المادة اكلينيكيا على عدد من المرضى و باستخدام جهاز الأشعة.

من خلال البحث تم التوصل الي النتائج اللآتية:

١- وجد أن التفاعل الألتهابى وعدد الخلايا الألتهابية المصاحبة لة والمحيطة بالمواد المدروسة ، يقل تدريجيا من ثلاثة أيام وحتى ستة أسابيع.
٢- وجد أن هذا النظام الجديد يسمح بتسرب الصبغة عند استخدامة بالطريقة الجانبية والطرقة الرأسية فى حشو قنوات الجذور.
٣- وجد أن قوة الربط للنظام الجديد أضعف من قوة الربط للجوتا بركا عند استخدام الطريقة الجانبية ولكنها تحسنت مع استخدام الطريقة الرأسية.
٤- وجد أن أداء نظام الأبيفانى كان مقبولا اكلينيكيا .

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Introduction

In the endless search for the perfect instrument, instrumentation technique, cleaning agent, and filling material; the substantial concern was always related to improving the quality of the interface between the filling material and the dentinal walls.

Nevertheless, all branches of restorative dentistry have suffered, and continue to suffer, from problems and consequences of poor adaptation of different types of restorations, with eventual ingress of fluids and bacteria. Reestablishing a medium for growth and proliferation with subsequent pathological problems.

Following the elimination of the offending cause from the tooth, it all revolves around housing an inert material in a well cleaned and shaped cavity to hinder the recurrence of the irritant.

This material should, in the first place, not irritate vital tissues. It should cut out any communication between the inside and the outside of the tooth, be radiopaque for proper visualization on a radiograph, and should be easily manipulated whether on insertion or retrieval for retreatment purposes.

Basically, two materials are used in combination for the filling of root canals. A solid core is employed to fill the bulk of the space, and a cementing substance is used for the purpose of filling discrepancies which exist between the solid core and the walls of the root canals.

To date, only gutta-percha has collected all the pros of a proper endodontic filling material. Although it has the ability to adapt to canal walls by virtue of its plasticity, still it lacks the first requirement of a good filling material "**adhesiveness"**.

As yet, no root canal sealer has all the ideal properties. Most leak with time, either through poor initial adaptation to the canal walls or due to solubility and disintegration.

If all of the standard luting cements and filling materials are faulty in their sealing ability, what can be done to prevent microleakage? The answer appears to lie in the use of the new adhesive resins, or glue that will adhere to all tooth structures as well as to other resins.

As we are stepping into the new millennium with revolutionary generations of mechanized instruments - all virtually invented for the sake of establishing thorough placement of the filling material – would it be appropriate to start thinking of a material that would finally achieve the goal??

Only during the past few years has the gutta-percha been challenged by other, synthetic materials in the production of root canal fillings.

The manufacturers advertised a polycaprolactone-based material, looking and handling exactly like gutta – percha. They claimed its perfect sealing as well as strengthening properties by the formation of a monoblock with the sealer and the dentine.

The question now is "is it about time for changing of the guards??' Would the 150 years-old gutta – percha retire peacefully and gracefully to clear the way for the young generation of soft resin materials??

Discussion

Because of the better comprehension of the biologic objectives and the rapid technological advancements with which endodontology is blessed, the specialty is progressing.

Proper elimination of the irritant is the primary goal. Unfortunately this does not ensure the long-term health of the tooth. Therefore, the placement of a material with the aim of preventing the ingress of the irritants back into the root canals together with being tissue friendly itself, is mandatory.

This is why once the "Epiphany" of such material has been announced; a 3-part study was run to evaluate its tissue tolerance, sealing ability, and clinical performance.

The first part was concerned with the assessment of the biocompatibility of the different components of the Epiphany system.
Implanting the test article inside the body of a laboratory animal is the most direct means of evaluating a material's potential effects on the surrounding tissues, and allows the evaluation of the toxicity of the unset material on a long-term basis.
The materials were implanted intraosseously to avoid the inflammatory reaction induced by the implant mobility [145].

The tested material was inserted using polyethylene tubes [146, 147] to allow precise control of the amount of material that will be in direct contact with tissues.

The experimental and control materials were placed within the same animal – yet at separate sites – to preclude the effect of the difference in body resistance among animals.

For histopathological examination, the FDI (Fédération dentaire internationale) guidelines were followed by subjectively assessing the intensity of the inflammatory reaction [142].

Findings of the present study showed that, with the exception of the primer, there was a tendency for the tissue reactions observed at 3 days to remit with time.

Resilon samples elicited reactions comparable to those observed with the control material at all observation periods. This confirmed the *in vitro* findings by Susini *et al*. [80], Key *et al*. [84], and Merdad *et al*. [85], and agreed with the results of the subcutaneous implant test conducted by Onay *et al* [87].

The long-term results of this study agreed with those obtained by Mohamed *et al*. [88] at 3 weeks of contact between Resilon cones and the subcutaneous tissue of mice. However, the severe reactions they had at 1 week were opposite to the mild reactions demonstrated in our study at the same period. They suggested the cone polymer content or the large surface area of contact as possible causes of the observed reaction.

The Epiphany sealer had higher mean scores than the Resilon specimens. This was not of statistical significance at any observation period as previously outlined by Onay *et al*. [87] and Mohamed *et al* [88].

On the other hand, the severe tissue reaction observed with the primer at 3 days, supporting Bouillaguet *et al*. [81] in vitro results, persisted at 1 week, and started to imperceptibly subside by 6 weeks. Therefore, this material recorded much higher scores than the Resilon or the sealer. This did not agree with Mohamed *et al*. [88] findings.

Tissue reactions to a material reflect a combination of the chemical nature of the material and the response to its physical state [148, 149]. The chemical stability and solubility are of great importance. Besides, smooth surfaces produce much less reactions than do rough irregular surfaces [148].

Indeed, the tissue reaction to the polytetrafluoroethylene tubes, which served as negative control, was in line with previous publications endorsing its harmless behavior [9]. It only reflected the trauma caused by the surgical procedures necessary for the implantation [86].

The Resilon disks – presenting a smooth flat surface – behaved the same way. This suggested a stable chemical nature in spite of previous reports [76, 77] on its biodegradability when subject to alkaline or enzymatic hydrolysis.

Likewise, the Epiphany sealer, being loaded flushed with the end of the tube, not only presented a smooth surface but also did not extrude into the adjacent connective tissue. Thus the inflammatory reactions observed at its surface were most likely related to its chemical profile.

In this study, freshly mixed sealer was used because the goal was to assess the tolerance of living tissues to extruded material during root canal treatment. However, Nielsen *et al*. [70] reported incomplete setting of the Epiphany sealer after more than 3 weeks when placed in contact with phosphate buffered saline. This suggests the presence of a reactive surface leaching out its ingredients into living tissues. Those consist mainly of monomers such as the bis glycidyl methacrylate, urethane dimethacrylate, and ethoxylated bis phenol dimethacrylate. All of them are known to be potential irritants for living tissues [150, 151, 152]. Among the fillers contained in the resin matrix is the calcium hydroxide, whose alkalinity could have played a role in reversing the acidic inflammatory medium and contributed to the repair process [153].

As for the self-etching primer, the elution of HEMA whose cytotoxicity was previously established [152, 154, 155], combined to its acidic pH were quite enough to severely irritate the tissues.

Nonetheless, the vehicle that has been used to seat the primer within the carrier might have taken a part in the aggressive response of the offended tissues.
The evidence of dispersed cotton fibers in sections taken from primer samples may explain the broader fields of inflammation associated with them. It also brings to mind the typical picture of massive lymphocytic infiltration crowded in the vicinity of cotton suture materials [156].

This incident drew the attention to the variety of factors associated with *in vivo* methodologies that may conceal a true biological effect of a certain material.
The state of the material whether solid or liquid, its preparation in finely divided pieces [148], its vehicle, and its presence outside the carrier [157], not only affect the intensity but also the extent of the reaction. This is in addition to the major limitation associated with the surgical operation, which, by itself represents a trauma to the tissues eliciting an inflammatory reaction [158].

The biological risks of an endodontic material are not only related to its toxicological properties, but they also stem from its ability to prevent leakage.
This is why another part of the research was done. It consisted of a series of laboratory tests with the aim of studying the sealing behavior of the Epiphany system when compacted with two obturation techniques.

The selected samples were single – canalled teeth to exclude anatomical variations and complexity factors. They were decoronated for the same reason, and were adjusted to the same length to reduce variability among groups [159].

Preparation of continuously flared canals through the use of the ProTaper system was done in the sequence recommended by its manufacturer. By engaging and cutting specific areas of the canal, each instrument performed its own "crown-down" preparation [160]. Thus ensuring the obtainment of a tapered canal with smooth transition from the apical third to the middle third. This allowed the condensing instruments to reach the deepest portion of the preparation, [161, 162], and the molten material to flow into canal irregularities [163], being considered critical factors in leakage control.

The shaping procedure was assisted by irrigation with 2 ml of 2.6% NaOCl after each instrument to flush out debris and lubricate the canal. However, its chemical effect ceased by a 3-minutes bath of 17% EDTA [164], which was followed by a generous rinse of distilled water. This was particularly recommended by the manufacturer of the Epiphany system to eliminate the effect of residual NaOCl on free radical polymerization.

The lateral condensation of cold points was chosen because it has been the benchmark for obturation for many years.
It is the most widely taught in dental schools and used by practitioners. It has long been the standard against which other methods of canal obturation have been judged [30].

The selected master cone was checked for resistance to removal when placed at the working length. This is because master cone adaptation is considered an important factor in the development of a fluid – tight seal at the apical extent of the canal [165].

Moreover, the root canal wall should be completely covered with sealer after obturation [166]. Therefore, the standard volume of sealer used in this study was spun into the canal using the Lentulo spiral and the master cone because they were found to be the best methods for effective sealer distribution [167, 168, 169].

Obturation was terminated by vertically compacting the coronal portion of the filling after searing off the excess in an attempt to improve the adaptability to canal walls [170].

Various methods have been suggested to assess the sealing potential of root canal fillings [90, 93, 99, 106]. The linear dye penetration method was selected because it is simple to perform. It is based on the supposition that it indicates the length of the gap between the root fillings and the canal walls [171]. The methylene blue dye has a low molecular weight, comparable to that of bacteria and their products [172, 173]. It does not adsorb or react with dental tissues, and is readily detected under visible light [174]. Longitudinal splitting enabled the demonstration of the pattern of dye penetration. The extent of dye penetration was recorded at 3 observation periods, which presented the freshly mixed state and different periods after setting.

This method showed that the sealing ability of the laterally condensed gutta-percha/AH Plus did not significantly change with time at the apical and the coronal levels, albeit some tendency for better sealing. This was in line with other publications considering differences in methodologies and storage times [102, 103, 175 – 177]. In contrast, some authors reported higher values of dye penetration [62, 178] and found that AH Plus lost its seal with time [178]. In reality, the longest period of evaluation in their study was 10 days. Actually this was the immersion time not the storage time. So logically the more the time of immersion the more the penetration which was further measured from the end of the root, not from the apical end of the filling as it was done here.

The present study also revealed significantly more coronal leakage at all observation periods, which agreed with the findings of De Moore and De Bruyne [176].

Conversely, the extent of coronal and apical dye penetration of the laterally condensed Epiphany system increased significantly with time to confirm the findings of Mohamed *et al.* [88], Paqué and Sirtes [103], De-Deus *et al* [104], and Shemesh *et al.* [106, 107]. In this group, the apical seal was initially better than the coronal one, but the dramatic loss in seal apically combined with its gradual loss coronally narrowed the difference to become non significant by 6 weeks.

Consequently, the laterally condensed gutta-percha and Epiphany performed almost equally up to 2 weeks at the apical third. Afterwards significantly more leakage occurred with the Epiphany.
In this regard, our results agreed with those of Biggs *et al.* [102], Paqué and Sirtes [103], and Shemesh *et al* [106].
Hashem and Tewfik [90] and Mohamed *et al.* [88] noticed the superiority of gutta-percha fillings earlier than we did.

In addition to the fact that the sealer used in their study was the AH26 and the tracer was India ink, this could also be related to the difference in the management of data. The mean dye penetration value for the Epiphany fillings was almost twice that of the gutta-percha fillings at 24 hours [90] and one and half times more at 1 week [88]. In the present study, it was one and half times more at 2 weeks as well; but the parametric statistical tests used in their studies were probably more sensitive to those differences than the tests used in this study.

On the other hand, significantly more coronal leakage was consistently observed with the Epiphany fillings, which was opposite to others' results [94 – 96, 98, 100]. This contradiction may be because their methodologies were confined to bacterial penetration and animal studies.

Hashem and Tewfik [90] accounted the gross leakage of the laterally condensed Epiphany for the possible disruption that could be caused by spreader penetration alongside the master and auxiliary cones. They substantiated their assumption with the better sealing obtained when they used greater tapers of the obturating points.

However, the most likely cause of microleakage in methacrylate-based materials is the volumetric shrinkage that occurs concurrently with polymerization of the resin [75, 179]. This is further intensified by the very unfavorable configuration of the endodontic cavity as expressed by the high C-factor [179]. Since polymerization shrinkage forces are directed towards the centre of the restoration, the resulting stresses will be directly transmitted to the weaker interface [179], eventually pulling the filling away from dentine. This issue becomes even more important when the sealer is light-cured to create an immediate coronal seal [67]. Thereby it eliminates an important avenue for stress relief by resin flow [119, 180]. This can actually be one reason for the poorer sealing behavior of the Epiphany coronal fillings.

Comparatively speaking, AH Plus sets within 24 hours in all conditions [70], is insoluble [71, 181, 182], shows continuous expansion [183, 184], and a smooth surface almost exempt of pores or vacuoles. A fact that might affect its integrity, durability and impermeability [185].

Furthermore, the flow of the sealers [182], implying their viscosity [186], determine how effectively voids between the master and accessory cones may be obturated [182]. In this respect, AH Plus and Epiphany sealers present acceptable flow [91], since they both behave pseudoplastically [182], exhibiting decreased viscosity with increased shear rate during spreader penetration, or with warm application.