

The Weak Link in Endodontics: Gutta-Percha—A Need for Change

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ABSTRACT

The use of gutta-percha as a standard obturation material over more than 100 years has made little changes in the obturation technique. With the advent of bonding and composite resins as a routine restorative material, the concept of bonded obturation has come into picture. The Resilon-Epiphany system has brought about a paradigm shift in the conventional obturation technique. This article explores the possibilities of the material as a replacement for gutta-percha. It also discusses the currently available forms of the material and a clinical case depicting its use.

Keywords: Gutta-percha, Obturation, Resilon-Epiphany system, Bonded obturation.

INTRODUCTION

Every aspect of endodontic treatment is imperative in obtaining a successful outcome. The steps of cleaning and shaping of the root canal have been stressed upon after a consensus regarding the fact that we are treating the 'root canal system' and not a single root canal in most cases. The importance of achieving a good coronal and apical seal cannot be over-emphasized. How good is a good seal? A number of terms have been coined for this, like a hermetic seal, fluid tight seal, fluid-impervious, bacteria tight, etc.¹ Also researchers have tried various combinations of paste, semisolid and solid materials along with or without sealers for obturating the root canal system. Gutta-percha has however stood the test of time and accepted universally as the obturating material of choice for the past 140 years since its introduction in 1867 by Bowman due to a number of advantages, inherent of the material.

Back to the Future

Looking back at the materials that were used for obturation, the most traditional methods involved the use of amalgam, asbestos, balsam, bamboo, cement, copper, gold foil, iron, lead, oxychloride of zinc, paraffin, pastes, plaster of paris, resin, rubber, tin foil, etc., to fill spaces in the root canal after removal of pulp tissue.² Silver points as a single cone for obturation were introduced in the era of a two-dimensional seal of the root canal.

The need for a more homogenous seal was realized and combination of silver cones with various sealers came into existence. However, the advent of gutta-percha and sealer combination revolutionized endodontics by promising a perfect seal of the root canal. Through properties like compressibility, inertness, dimensional stability, tissue tolerance, radiopacity, it becomes plastic when warmed, removes easily with solvents, elongatable when fresh and brittle when old.³

A number of variations with gutta-percha itself were experimented like thermomechanical compaction (using McSpadden compactors), chemically plasticized gutta-percha (using materials like chloroform/xylol/eucalyptus oils) and finally variations in thermoplasticized gutta-percha techniques (using metal/plastic core carriers or injectable materials supplied in the form of pellets). Studies have shown that canals obturated using these techniques provide a better apical and coronal seal as compared to the conventional lateral condensation technique.⁴⁻⁸ Eventually, shrinkage occurs within gutta-percha itself resulting in spaces along the gutta-percha-dentinal wall interface resulting in failures due to poor apical or coronal seal and ultimately causing bacterial microleakage within the root canal.

Why does Conventional Gutta-Percha Fail?

Though it has a number of advantages but these only satisfy the secondary requirements of an ideal obturating material. The primary requirements of being an antimicrobial material and sealing all the portals of exit in the root canal system are not satisfied by gutta-percha.

Some other shortcomings of gutta-percha as an obturating material are as follows:⁹

1. Gutta-percha has no inherent ability to seal canals, except perhaps by a physical one with the flow into lateral canals via warm vertical techniques.
2. Gutta-percha does not bond to canal walls.
3. Gutta-percha does not bond to any sealers.
4. For all intents and purposes, gutta-percha is a filler that has no other significant function. It has been chosen because of its lack of toxicity, ability to be thermosoftened and compacted, ability to be retreated, and its lack of an alternative more than any other single set of factors.

5. Gutta-percha is almost wholly dependent on a coronal seal to prevent the apical migration of bacteria if it is challenged by coronal leakage. The endodontic literature is absolutely clear that excellent coronal seal is correlated with clinical success irrespective of the presence of gutta-percha.
 6. Only resin-based sealers have the potential to bond to canal walls when the smear layer has been cleared with a liquid EDTA solution.
 7. Gutta-percha shrinks upon cooling, approximately 5 to 7%.
 8. Gutta-percha has changed very little since it was introduced into dentistry at the beginning of this century.
6. Elimination or considerable reduction in microbial leakage. Since it is a new material, these claims however require to be substantiated with adequate amount of evidence.
The Resilon-based obturation systems consist of three major components, which include:
 1. Primer
 2. Sealer
 3. Obturator.Each of these components is described as follows:

A New Beginning

In the effort to search for alternatives to gutta-percha, newer materials were experimented like Hydron or poly-2-hydroxyethyl methacrylate, supplied as a powder and paste, which after mixing forms a hydrophilic gel that swells on contact with water. This material was injected into the root canal using a screw pressure syringe. Though initially claimed to be well tolerated by tissues (Benkel et al, 1976), Langeland et al (1981) found that it evoked a moderate to severe inflammatory response and was resorbable, while Director et al (1982) concluded that it showed significantly more leakage than laterally or vertically condensed gutta-percha. This material has been regarded as an experimental material since it did not become popular amongst clinicians because of its drawbacks.^{10,11}

The success of bonded restorative techniques has revolutionized dentistry in recent years, owing its success to advanced techniques and state-of-the-art materials. Some of the same principles from these techniques and materials have been incorporated in endodontics to offer a new approach to filling root canals—an internally bonded restoration. Resilon is believed to be the material of the 21st century with 'gutta-percha-like' handling and properties, and the ability to bond to the sealer which in turn bonds to dentin within the root canal. This eliminates the probability of microleakage between the core material-sealer interface and sealer-dentin interface. Resilon is a thermoplastic synthetic polymer material based on polyester. It also contains bioactive glass, bismuth oxychloride and barium sulphate (65% filler by weight). It is a fully polymerized resin, slightly more radiopaque than gutta-percha. It is available in standard and nonstandard cones as well as pellet form.

Resilon-Based Systems

Kaufmann has enlisted the following advantages offered by Resilon:¹²

1. Enhanced root fracture
2. Better radiopacity than GP
3. Dual cure capabilities for immediate coronal seal
4. Causes less irritation than epoxy or ZOE sealers
5. No learning curve beyond the traditional GP approach

Primer

The primer is a self-etching system that is cured by the sealer. The primer penetrates all the dentinal tubules. The bonding procedure is preceded by irrigating with a 17% solution of EDTA. This last process is necessary for removing oxide radicals from the NaOCl and peroxides. Failure to do so will cause an interference with the curing potential of the dentin bonding agent.

Sealer

The sealer bonds to the primer thereby eliminating potential for microleakage. The sealer used in this system is a dual cure bis-GMA, ethoxylated bis-GMA, UDMA, hydrophilic difunction methacrylate. Fillers like calcium hydroxide, barium sulphate and barium glass are present 7% by weight. It contains the catalyst that sets up the self-etching primer in the dentinal tubules. In the possible presence of microbes (decreased pH), calcium hydroxide increases its pH to 11.0 automatically.

Obturator

The Resilon obturator is a thermoplastic polyester and contains the following components: (1) Bioactive glass, (2) barium sulfate and (3) bismuth oxychloride. The bioglass is a unique component that forms calcium/phosphate when in contact with body fluid. It does not dissolve in fluid but instead it releases ions to stimulate the formulation of osseous tissue. As already mentioned, its radiopacity is better than GP, condenses laterally and vertically as GP and softens at around 70 to 85°C. Finally, the Resilon obturator bonds to the surface of the sealer which in turn bonds to the primer that has hybridized with the tubular surfaces.

Thinning Resin

In addition to the above, most systems include a thinning resin, which may be added in 1 or 2 drops to thin the sealer to the desired viscosity.

The 'Monoblock' Concept

The Monoblock concept means the creation of a solid, bonded, continuous material from one dentin wall of the canal to the other. Dr Franklin Tay has classical examples of Monoblocks in dentistry into three categories depending upon the number

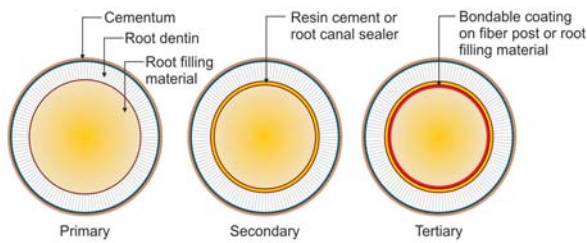


Fig.1: Cross-sectional illustration demonstrating the types of monoblocks

of interfaces present between bonding substrate and filling material core¹³ (Fig. 1).

Primary: Hydron may be regarded as one of the first monoblocks in dentistry. Obturations done purely with MTA in cases of apexification may be regarded as a contemporary version of the primary monoblock.

Secondary: Resilon-based systems come under this category, which involves a bond between an etched layer of canal dentin impregnated with resin tags that are attached to: A thin layer of resin cement that is bonded to a core layer of Resilon, which makes up the bulk of the filling material.

Tertiary: Comprise of the EndoRez and Activ GP systems currently available; which consist of conventional gutta-percha surface coated with resin or filler coating which bond with the sealer that in turn bonds to the root dentin.

Monoblocks aim at achieving a single unit which would reinforce the tooth structure. However, all the root canal filling materials available today have a modulus of elasticity that is far less as compared to dentin (i.e. 14,000 MPa), which questions the effectiveness of this concept.

Resilon Delivery System

The Resilon-based obturation systems are available in standardized points that correspond to endodontic instruments and in various tapers, i.e. 2, 4 or 6%. They are also available as nonstandardized points X-fine, fine-fine, medium-fine, fine, fine-medium, medium, medium-large and large sizes as well as pellets for use with thermoplasticized delivery system in the range of (105-150°C). Various techniques can be employed to place this material in the canal (single-cone method, cold lateral condensation and thermoplastic techniques), with the same instruments and devices that are used for gutta-percha condensation.

With the development of this material, a number of manufacturers have introduced newer Resilon-based obturation systems like:

- Pentron Clinical Technologies with its Epiphany™ system (<http://www.pentron.com/>).
- SybronEndo with RealSeal™ and its Elements™ Obturation unit (<http://www.sybronendo.com/>).

- Obtura Spartan with Resinate™ and its Obtura™ obturation system (<http://www.obtura.com/>).
- Discus Dental Endodontics with its SimpliFill™ filling system (<http://www.discusdental.com/>).
- Heraeus Kulzer which introduced its Next™ endodontic obturating system followed by InnoEndo™ endodontic obturating system (<http://www.heraeus-kulzer-us.com/>).

Epiphany™ System

The components of this system include standardized points in sizes from 15 to 60 with 0.02 taper, sizes 15 to 60 in 0.04 taper or sizes 15 to 45 in 0.06 taper. Accessory points available as nonstandardized points in: XF, FF, MF, F, FM, M, ML and L sizes. Epiphany pellets are also available to be used with conventional thermoplasticized gutta-percha systems. The Epiphany sealer is recommended to be used with the Epiphany self-etch primer or a simpler alternative of using the Epiphany SE self-etch sealer that eliminates the priming step (Fig. 2).

RealSeal™ and Elements Obturation Unit

RealSeal system is quite similar to the Epiphany system, i.e. it includes standardized, nonstandardized points and pellets. The system is available in two variants RealSeal system and the RealSeal Self-Etch™ system. The Self-Etch system eliminates the priming step. The RealSeal Hi Flow pellets available with the RealSeal system are used with the Elements obturation unit (Figs 3A and B).

If using Obtura™ or System B™ to backfill the obturation with RealSeal Hi Flow pellets, use of the following settings are recommended by the manufacturer:

Obtura

- For the 25 gauge needle tips, set the temperature to 125°C.
- For the 23 gauge needle tips, set the temperature to 115°C.
- For the 20 gauge needle tips, set the temperature to 105°C.



Fig. 2: Components of the epiphany obturation system



Figs 3A and B: (A) Components of the RealSeal obturation system, (B) elements obturation unit from Sybron Endo

System B

Set the temperature to 150°C and the power to 10.

Resinate™ and Obtura™ Obturation System

Resinate system is again similar to the Epiphany system, i.e., it includes standardized, nonstandardized points and pellets. The sealer is delivered from an automix syringe. The Resinate pellets are designed to be used with the Obtura thermoplasticized obturation system (Figs 4A and B).

SimpliFill™ Filling System

Compatible for use with the LightSpeed system of NiTi Rotary Instruments is similar to the gutta-percha obturators and available in apical sizes 35 to 130 and in 25, 31 and 50 mm lengths. The system also includes Resilon Pellets to be used with the HotShot gun for backfill (Figs 5A and B).

Next™ and InnoEndo™ Endodontic Obturating Systems

The Next™ endodontic obturating system was introduced initially followed by the InnoEndo™ endodontic obturating system. This system recommended the use of the Liberator System of rotary NiTi 0.04 tapered instruments. The system utilizes a two-bottle bonding system followed by the use of either an InnoEndo obturator (for straight single canals) or the tapered obturator designed with a resin fiber carrier (for posterior teeth) bonded using a dual-cured root canal sealant. The system claims to provide a simple solution to obturating as well as reinforcing teeth for providing a post and core in a single appointment (Fig. 6).

Research on apical seal of Resilon-based systems has shown that irrespective of the technique used for obturation, i.e. lateral condensation or vertical compaction using thermoplasticized materials, the Resilon-based systems have shown less apical leakage as compared to gutta-percha points used with various sealer combinations or gutta-percha thermoplasticized systems.¹⁴⁻¹⁷ In addition to apical seal, the need for coronal seal also came into picture when post endodontic restorations were placed. Clinicians have tried to achieve coronal seal by placing various materials like cavite, glass ionomer cements or flowable composite over the orifice openings in an effort to achieve coronal seal,¹⁸⁻²² but with obvious risks of locating these orifices



Figs 4A and B: (A) Components of the Resinate obturation system, (B) Obtura™ obturation unit for backfill



Figs 5A and B: (A) Components of the SimpliFill filling system, (B) HotShot™ obturation unit for backfill

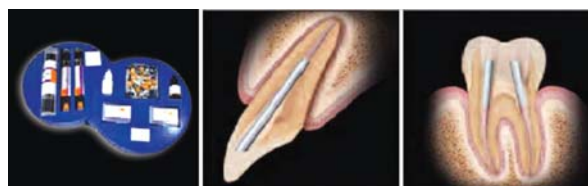


Fig. 6: Components of the Next™ and InnoEndo™ endodontic obturating systems

in the cases of retreatment. Studies on coronal seal with Resilon-based systems have also shown that they are better than gutta-percha.²³

With respect to the increase in fracture strength due to 'Monoblock-effect', filling the canals with the resin-based

obturation material increased the *in vitro* resistance to fracture of endodontically treated single-canal extracted teeth when compared with standard gutta-percha techniques. However, the differences were not significant indicating that the material is as good as gutta-percha in this aspect.²⁴ In cases which require retreatment; techniques and materials used for gutta-percha can also be used for the cases treated with Resilon.

Is Resilon the Solution?

A lot of research on Resilon-based systems has been carried out till date (<http://www.resilonresearch.com/>). Studies have shown conclusive evidence of Resilon being equally effective or even superior to gutta-percha based systems, however long-term studies on leakage comparing gutta-percha and Resilon-based systems have shown that though initially, Resilon/Epiphany root fillings prevented fluid movement to the same degree as gutta-percha/AH Plus counterparts, they showed more fluid movement when tested at 16 months.²⁵ Others demonstrated that Resilon/Epiphany combination does not improve the bacterial leakage resistance compared with traditional gutta-percha/sealer fillings.²⁶

Dr Franklin Tay has also recognized the presence of the configuration factor or C-factor that is seen in bonded restorations in cavities and concluded that the high C-factors in root canals impose challenges in creating endodontic monoblocks. His research on polymer constituents of Resilon has shown degradation by bacterial and salivary enzymes.²⁷

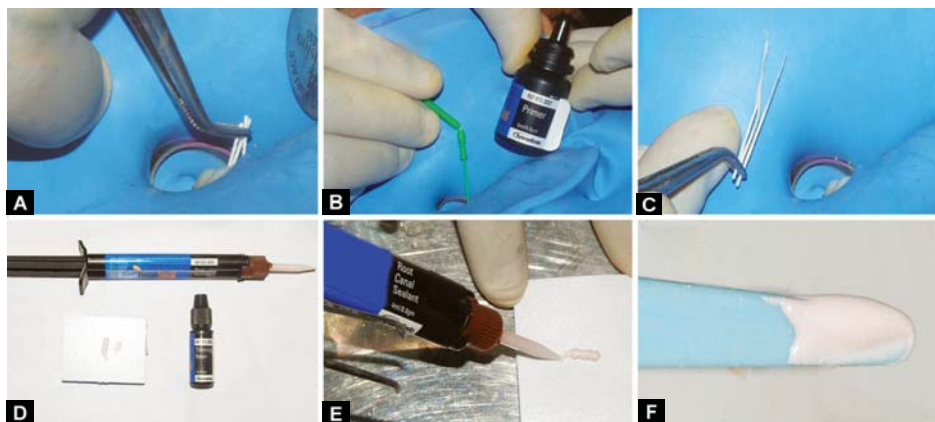
Also, long-term clinical research with Resilon-based systems has yet to show its proven results. The question of biocompatibility of periapical tissues with resin-based systems and leaching of resin by-products still exists. So, due to the nonresorbable nature of resins, the removal of obturating material in the cases of overfills is a major concern.

CLINICAL CASE

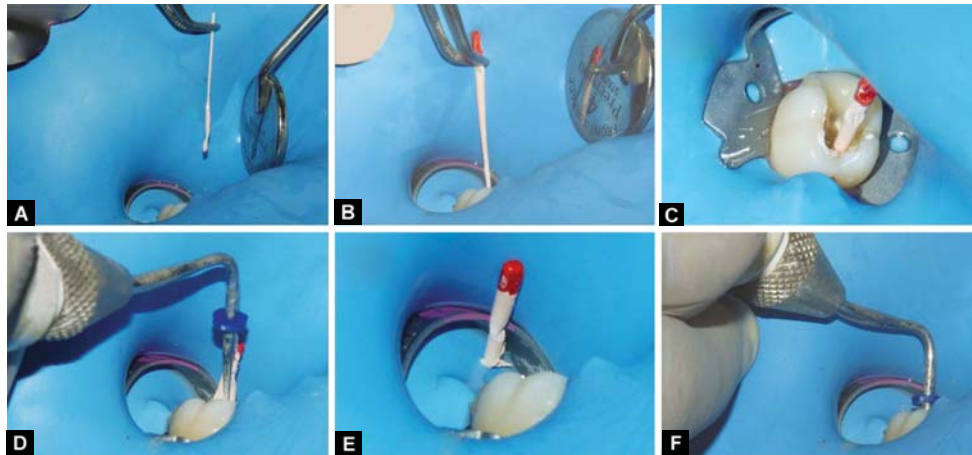
A patient reported to the department of conservative dentistry and endodontics at MA Rangoonwala Dental College with a chief complaint of pain in the lower right posterior region. Patient complained of pain on chewing and on consumption of

cold water and food. On clinical examination there was a cavitation present on the distal aspect of the mandibular right 1st molar. Radiographic examination revealed caries extending near the distal pulp horn. A decision to perform root canal therapy for the tooth 46 was taken and the patient was anesthetized and tooth isolated under rubber dam. Following access preparation three canals were noted, i.e. MB ML and distal. Instrumentation was performed using hand instruments and apex locators combined with radiographs to determine working length followed by shaping using ProTaper Universal Rotary instruments in the sequence of S1-Sx-S1-S2-F1-F2. Irrigation was performed between each instrument using a combination of 17% EDTA and 5.25% NaOCl. Following completion of the cleaning and shaping procedure, the access was sealed using a cotton pellet and Cavit-G (Seefeld, Germany). The patient was called the following day for obturation.

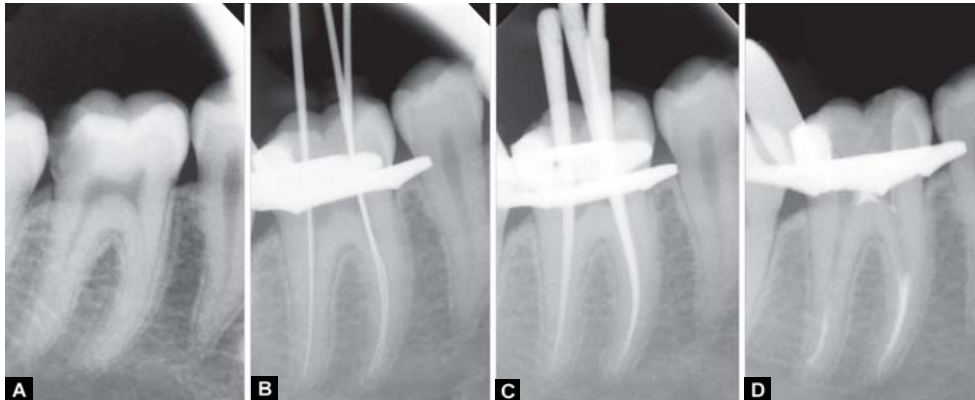
In the next appointment, the temporary dressing was removed and the canals were rinsed with Smear Clear 17% EDTA solution (SybronEndo, CA, USA). The solution was activated using Irrisafe tips attached to the Satelec P5 Newtron ultrasonic unit (Acteon Equipment, France). A vertical compaction technique of obturation using the RealSeal system was chosen. The canals were dried using paper points. Specialized 25 number, 6% Resilon points available with the RealSeal system were used to check the tug-back clinically and verified radiographically. This was followed by application of the primer from the RealSeal System using an Endo applicator tip. Excess primer was removed by placing paper points to prevent pooling of the primer in the root canals. The RealSeal sealer was mixed using the automix syringe followed by addition of a drop of thinning resin to improve the flow properties of the sealer. The sealer was coated along the canal walls using paper points (Figs 7A to F). This was followed by coating the Resilon points with a small amount of sealer and introducing them in the respective canals. The downpack was performed using the heat-activated carrier. A section of the Resilon point was seared at the orifice level followed by compaction using a hand pluggers. The heat carrier was then marked to proper length



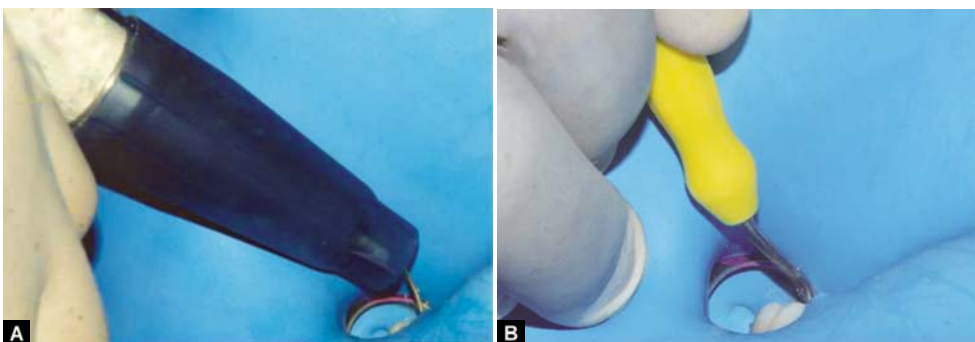
Figs 7A to F: (A) Paper points used to dry canal prior to obturation, (B) primer applied using endodontic microbrush, (C) excess primer dried using paper points, (D) RealSeal sealer and thinning resin with mixing pad, (E) sealer dispensed through auto-mix syringe, (F) final mix of sealer after incorporating thinning resin



Figs 8A to F: (A) Sealer applied to canal walls using paper points, (B) Resilon points coated with sealer introduced in the canal, (C) Resilon points placed to working length, (D) heat-activated carrier used to sear Resilon points at orifice level, (E) coronal section of Resilon point seared-off till middle-third of root, (F) complete insertion of heat-activated carrier to marked length



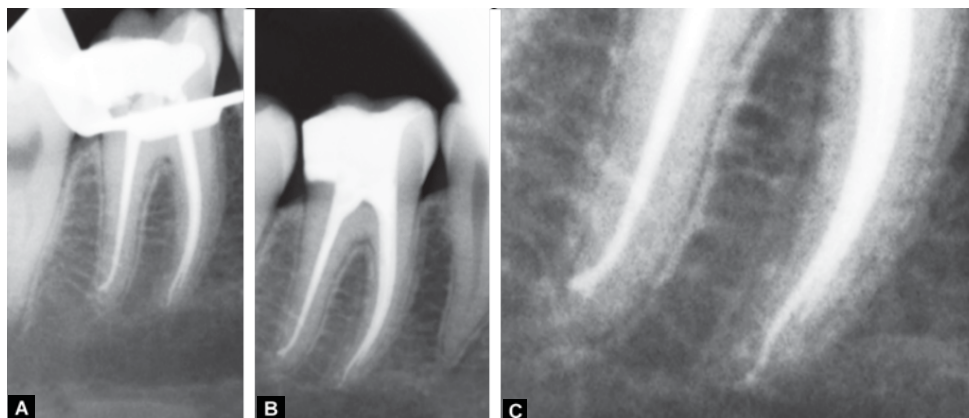
Figs 9A to D: (A) Preoperative radiograph showing carious lesion in proximity to distal pulp horn, (B) verifying 10 no. K-files placed to working length, (C) checking fit of master cones following cleaning and shaping, (D) downpack of Resilon points done using heat-activated carrier



Figs 10A and B: (A) Backfill done using thermoplasticized Resilon pellets and Obtura gun, (B) coronal pluggers used to condense obturation material

(approximately 4 mm short of working length) and inserted to provide a continuous wave of condensation. The softened mass was vertically compacted using appropriately sized pluggers

(Dentsply Maillefer, Switzerland) (Figs 8A to F). A radiograph was taken to confirm the downpack, which was followed by the backfill using Obtura (Obtura/Spartan, USA) (Figs 9A to D).



Figs 11A to C: (A) Radiograph to verify backfill with thermoplasticized Resilon, (B) complete apical and coronal seal achieved (C) apical 3rd of obturation showing well-compacted Resilon obturation material

The Obtura gun was preloaded with the Resilon pellets and heated at 150°C. Following the downpack, the thermoplasticized Resilon was syringed and compacted using larger sized coronal pluggers. A radiograph was again taken to confirm the backfill. The access was sealed by light—curing the material at the orifice level. This was followed by the postendodontic restoration (Figs 10A and B). A final radiograph confirmed adaptation of the obturation material at the apical level and achievement of coronal seal (Fig. 11).

CONCLUSION

In conclusion, though the advances in technology have brought about a positive change in the cleaning and shaping procedures; the effective sealing of the root canal system still remains a concern amongst clinicians and researchers. Though the newer methods have not made their mark yet they have made us ponder over our age-old materials and opened new doors to an alternative approach to successful endodontics.

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