Resilon root canal filling material review: microleakage, fracture resistant, retreatment

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ABSTRACT

Chemically, bonding root canal filling gives a greater apical and coronal seal. It is resilon, which is a thermoplastic synthetic polymer-based on polymers of polyester containing bioactive glass and radiopaque filler introduced in 2004. Electronic literature was done by searching two international databases, PubMed, and Google Scholar, to find out most of the articles that were relevant to resilon. Searching was done by 3 reviewers to collect 41 investigated articles between 2000 and 2019, using the following keywords “Resilon” and “Resin based root canal filling.” Within different tests to measure micro leakage and sealing ability of resilon. Clinical trials and Histology are the most reliable to confirm the biocompatibility and sealing ability of resilon. Literature showed that resilon (RS) obturation had adverse results when compared to gutta-percha (GP). Compared to teeth obturated with GP, teeth obturated with RS had 5.7 times increased likelihood of failure. RS showed outstanding properties; sealing ability is promising, performed using different methods. However, the push-out test is controversial compared with GP. The mono-block is a unique feature of such material that improves root fracture resistance. Therefore, clinically RS has more than five times failure compared to GP. Consequently, periradical pathosis and illness are still persistent post-operatively.

Keywords: Resilon, root canal filling, micro leakage, fracture resistant, retreatment.

Introduction

Since endodontic treatment has been practiced for more than 90 years; however, the main procedural steps have to be followed to eradicate intraradicular and periradicular infection and re-infection [1], which include removing pulp tissue, cleaning, and shaping, obturation, or filling the canal, finally placement of a permanent restoration [2].

According to the American Association of Endodontists, “Obturation is the method used to fill and seal a cleaned and shaped root canal using a root canal sealer and core filling material.” The function of root canal filling is to obturate or eliminate all entry between periodontium and root canal. Root canal filling material must achieve maximum ideal properties. There are ideal requirements of root canal filling materials which have been raised by Grossman, as the following; seal the canal apically and laterally, not shrink after insertion, set slowly, impervious to moisture, bactericidal or at least discourage the growth of bacteria, radiopaque, not stain the tooth, not irritant to periradicular tissue or affect tooth structure, could be sterile, easily or quickly sterilized immediately before insertion, and easy removal from the canals if required [3]. Theoretically, increased leakage could be obtained with poorly prepared canals or preparation on one side. However, a good or tight seal could be obtained from circumferential preparation [4].

New material has been raised to applying dentin bonding technology to the root canal. Chemically bonding root canal filling gives a greater apical and coronal seal. It is Resilon (RS) (Resilon Research, LLC, Madison, CT), which is a thermoplastic synthetic polymer-based on polymers of polyester containing bioactive glass and radiopaque filler introduced in 2004 [5]. RS contain 65% filler by weight [6]. RS cone has 2% taper resemble GP and could be obturated by either lateral compaction.
technique or vertical compaction technique, even though
by thermoplastic injection [7]. This filling material has
been used with a specific sealer called Epiphany, a resin-
based sealer that functionally bonds the canal and RS to
form a mono-block [7,8]. Epiphany sealer is dual-cure
and contains 70% of filler by weight. In addition, it is
composed of calcium hydroxide, barium sulfate, barium
glass, and silica [6].

The steps of obturation could be briefly summarized
as following, dry canal, applying self-etching primer,
excess removal, mixing of sealer and applying to working
length, light-cure the coronal section for 40 seconds [7].
Therefore, this study was done to conduct a literature
review on Resilon, microleakage, fracture resistant,
storage, setting time, disinfection, irrigation, retreatment,
and using it as retrograde filling.

Materials and Methods

Electronic literature was done by searching two
international databases, PubMed and Google Scholar,
and using the following keywords “Resilon” and “Resin based root
canal filling.”

Discussion

Micro leakage and sealing ability

In non-surgical endodontic treatment, root canal filling
is a crucial phase. The majority of recent investigations
have been focused on RS’s relative capacity to resist
leakage; nevertheless, the results have been mostly
controversial, with one group of studies claiming that RS
is superior to gutta-percha (GP) and the other claiming the
opposite. Comparisons are difficult due to the diversity
of methodologies used in these investigations, and the
clinical relevance of these in vitro studies is debatable.
However, despite evidence that RS performs better or
worse than GP in leakage investigations, extrapolating
relevant clinical findings is challenging. A more suitable
technique to test RS’s efficacy would be to examine the results in vivo; however, these investigations are time
demanding and uncommon in endodontics. RS is not
firm enough to reinforce the remaining root structure;
however, more information on the nature of the adhesive
bond between sealer and root dentine is needed, as well
as if the described in vitro “mono-block” is clinically
applicable. Because the use of resin sealers and bonding
within the root canal is very new, the predictability of
bonding in the apical reaches of the root canal must
be determined. Over the next few years, procedures
and materials are likely to advance, which could lead
to an improvement in both knowledge and results. RS
appears material compares favorably to GP in terms of
biocompatibility and physical qualities, while there are
worries about the Epiphany sealer’s cytotoxicity [9].

Clinical trials

Barborka et al. [10] published a first clinical trial to show
that RS obturation had adverse results when compared to
GP. Compared to teeth obturated with GP, teeth obturated
with RS had 5.7 times increased likelihood of failure.
Because many patients and teeth were treated with RS
obturation, post-endodontic illness is still a possibility.
Clinicians should be aware of the higher failure risk
associated with these cases and should regularly evaluate
the periapical health of these teeth in order to provide
appropriate therapy if necessary. Future research is
needed to confirm these findings and pinpoint the cause
of these errors [10]. Moreover, Strange et al. [11] within
the study’s limitations, teeth obturated with RS were
almost 5-fold more likely than teeth obturated with GP to
present with lesions at follow-up, implying that there is
no long-term benefit to utilizing this material over GP in
non-surgical root canal treatment.

Dye penetration

Melih et al. [12] performed the measurements using
methylene blue and longitudinal root sectioning, reported
that there were no significant variations in apical sealing
performance between RS and GP/AH-Plus; both provided
the greatest results. In addition, Pitout and Oberholzer
[13] study resulted that Resilon/Epiphany system (RES)
materials provide equivalent amounts of dye penetration
regardless of whether the Cold Lateral condensation
technique or the System B technique is utilized. However,
Punja et al. [14] reported that Gutta-flow had the highest
mean microleakage value, followed by Cold lateral
condensation, Thermafil, and RES. Between Resilon/
Epiphany and Gutta-flow, there was no statistically
significant difference in mean leakage values. Resilon/
Epiphany produces a superior seal than cold lateral
compaction, Gutta-flow Thermafil method.

Fathia et al. [15] exhibited that Resilon/Epiphany sealer
has superior apical sealing ability than GP/AH-Plus
sealer. Roy et al. [16] concluded that the teeth obturated
with the RES showed greater adaptability to the root
canal walls. Bhandi and Subhash [17] reported that RES
had the best sealing performance in vitro, followed by
Thermafil and GuttaFlow. Sultana et al. [18] investigated
by linear dye penetration technique microleakage test
revealed that the RS + Epiphany group had the least dye
penetration, followed by GP + Epiphany, GP + AH plus,
and GP + AH plus.

On the other hand, Al-Maswary et al. [19] RES failed to
deliver complete hermetic coronal sealing, indicating that
total sealing remains a challenge with this technology.

Microbial leakage model

Shashidhar et al. [20] reported that RS is found to be
superior in terms of microbial leakage resistance. Both
lateral and vertical condensation was shown to be
effective in obturating RS.Shipper et al. [21] reported
that the “mono-block” generated by the RS filling closely adapting to the Epiphany sealer and Epiphany sealer adhering to the dentin walls could be attributed to RS’s outstanding sealing capabilities. The GP filling peeled away from the AH 26 sealer in the high-power SEM micrograph, whereas the sealer remained against the dentin wall with its resin tags piercing the dentin tubules. This space between the GP and the sealer could allow for microleakage, which could explain the GP rapid leakage. As a result, the seal between the core material and the sealer appears to be essential for the Resilon/Epiphany resistance to leakage [21].

A Bacterial Leakage Study done by Fransen et al. [22] A split-chamber bacterial leakage model was built using Enterococcus faecalis to evaluate the sealing effectiveness of the ActiV GP/Glass Ionomer Sealer, Resilon/Epiphany, and GP/AH Plus Obturation. In conclusion, there were no statistically significant differences between the three obturation systems examined for any of the parameters tested. In addition, Pitout and Oberholzer [13] reported that employing either the Cold Lateral condensation technique or the System B approach, the bacterial microleakage of a root canal sealed with RS and Epiphany sealer is identical to that of a root canal sealed with GP and Roth root canal cement [13].

Digital radiographs

Veríssimo and Sampaio [23] reported that RES was unable to eradicate dye leakage, but it was limited to the apical third, and lateral condensation, and Hybrid technique could be employed to thermoplasticize RES with satisfactory results. Anna-Júnior et al. [24] revealed that RS outperformed both types of GP, particularly in the middle and apical thirds, and that it might be employed as a solid core material for root canal filling via thermomechanical compaction. However, more research needs to be done in order to assess other features [24].

Histology

Cardoso et al. [25] supported that RS’s use as a biocompatible material in vivo. However, although being validated, findings imply that RS’s long-term biocompatibility is inferior to GP control.

Alkaline hydrolysis

According to Mehrdad Lotfi et al. [26] biodegradation of RS could occur in the event of apical or coronal leakage, which jeopardizing the endodontic seal. Microorganisms produce an enzyme called lipase, which could cleave the ester linkages in polycaprolactone, making it more sensitive to alkaline and enzymatic hydrolysis. Fluid filtration technique

Rouhani et al. [27] found that Resilon/Epiphany provided a better seal in strongly curved root canals immediately after obturation than GP/AH Plus. Stratton et al. [28] reported that RS groups with self-etch primer and Epiphany resin root canal sealer were much more fluid resistant than the GP and AH Plus sealer groups. RS provides stronger resistance to in vitro fluid microleakage than GP, produces a better seal at the apical 5.0 mm of the root canal than GP, and might be a good alternative for GP, according to Wedding et al. [29]. Biggs et al. [30] concluded that Epiphany obturation system is as good as GP sealed with AHPlus or Roth’s sealers in vitro. To prevent in vitro leaking, we discovered that a sealer is required required in the case of Resilon/Epiphany [30]. More investigations are required, either in vivo or in vitro.

Push-out test

Gesi et al. [31] emphasized that within the scope of this investigation, it is reasonable to conclude that the interfacial strength achieved with Resilon/Epiphany to intraradicular dentin is not superior to that achieved with GP and a typical epoxy-resin sealer. The findings cast doubt on the idea of using a new root filling technology to reinforce root canals [31]. Moreover, Sly et al. [32] as a result, the push-out bond strength of GP/AH 26 to intraradicular dentin is stronger than that of the new obturation system Resilon/Epiphany. Some of the claims made for this new endodontic obturation technique are challenged by these findings [32]. In addition, De-Deus et al. [33] reported that the adhesiveness quality of both Epiphany sealers to root dentin is degraded when teeth with simple anatomic features were obturated under well-monitored laboratory circumstances. The fact that the AH Plus/GP root fillings have a higher push-out bond strength confirms that the era of conventional nonbonding root filling is far from over [33]. However, Skidmore et al. [34] measured the mean of micropush-out bond strength of Resilon/Epiphany filled root canals to intraradicular dentin, and it is considerably greater ($p = 0.05$) than GP and Pulp Canal Sealer EWT filled root canals. The idea of achieving complete mono-block obturation with no gaps, however, is challenged by SEM analysis. Further in vivo testing would be required to determine the clinical implications of these findings [34].

Strength and fracture resistant

In comparison to Gutta percha with AH 26 sealer, also to the lateral condensation technique. Filling canals with GP/AH plus fails to reinforce endodontically treated root canals. However, RS with vertical condensation technique increases fracture resistance, and could be used instead of GP [35-40]. Demonstrating that the mono-block concept is vital not only to resist bacterial penetration through the material but also to hold the root together, boosting tooth fracture resistance [41]. Thus, roots obturated with RS needed a larger loading force to fracture than those obturated with GP [42]. Moreover, endodontically treated teeth obturated with RS and restored with quartz fiber posts had much better compressive strength than teeth obturated with GP and restored with quartz fiber posts [43].
Intracanal medicament

Residues of calcium hydroxide used as an intracanal medicament have a negative impact on Resilon/Epiphany binding strength to the root canal dentin. Furthermore, ultrasonic instrumentation could be a valuable tool for the removal of these residues [44].

Removal of root filling

Although definitive judgments on how easy it is to remove compared to GP have yet to be established, it looks to compare favorably to GP utilizing a range of removal approaches [9]. RS is increased solubility in chloroform, and the fact that complete solution of the obturating ingredient is not required during the retreatment method, it is possible to use safer and weaker solvents [45]. However, xylene, refined orange oil, and tetrachloroethylene could also be utilized to soften GP/RS during retreatment using a variety of approaches. But the optimum solvent for GP and RS is xylene [46]. The ProTaper system appeared to be the most efficient approach for removing Resilon. Moreover, the most efficient methodology seemed to be a mix of manual and rotary devices with or without chemical solvents [47,48]. The findings also showed that RS is easy to remove and has a similar or better solubility in chemical solvents than GP, despite the fact that it might leave more debris behind [48,49].

Conclusion

RS showed outstanding properties; sealing ability is promising, performed using different methods, e.g., dye penetration, digital photography, histology, and fluid filtration technique. However, the push-out test is controversial compared with GP. The mono-block is a unique feature of such material that improves root fracture resistance. However, clinical wise RS has more than five times failure compared to GP. Therefore, periapical pathosis and illness are still persistent post-operatively. In addition, RS could be removed from the root canal by different rotary systems. However, ProTaper is considered as the most effective one, either using solvent or not.

Conflict of interest

The authors declared that there is no conflict of interest regarding the publication of this article.

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Consent to participate

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Ethical approval

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References

Resilon root canal filling material


Author Queries

AQ1 Please provide expansion for the abbreviations “AH, SEM, EWT.”

AQ2 Please provide reference for the in-text citation “Mehrdad Lotfi et al.”

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