Title: A laboratory comparison of apical leakage between immediate versus delayed post space preparation in root canals filled with Resilon™

Author: Attam and Talwar


Reviewer: Christian Lehr, D.M.D.

Purpose: To analyze ex vivo the integrity of the apical seal of Resilon™ root fillings following immediate post space preparation or after 1 week when leaving either 5 mm or 3 mm of remaining filling material.

Materials and Methods: One hundred fifty caries free single rooted mandibular premolars were used. Teeth were sterilized, kept moist by placement in sterile saline, and decoronated at the CEJ to leave 16 mm of root length. Working length was determined and all teeth were instrumented to size 45/.04. Apical patency was maintained with a size 10 K-file. Teeth were irrigated with 1% NaOCl, 17% EDTA, and distilled water. 30 teeth served as controls with the canals left empty (Group 1). The remaining 120 teeth were obturated with Resilon™ and Epiphany® sealer using cold lateral condensation with fine and medium-fine accessory points. An immediate coronal seal was created by light-curing the coronal surface of the Resilon™ filling with an LED curing light for 40 seconds. These teeth were then randomly divided into 4 groups of 30 teeth each.

- Group 2 – Immediate post space preparation with Peeso reamers 2, 3, 4 leaving 5 mm of filling material apically.
- Group 3 – 7 day delayed post space preparation with Peeso reamers 2, 3, 4 leaving 5 mm of filling material apically. Teeth were temporarily restored with cavite G and stored in enclosed containers while wrapped in moist gauze.
- Group 4 - Immediate post space preparation with Peeso reamers 2, 3, 4 leaving 3 mm of filling material apically.
- Group 5 - 7 day delayed post space preparation with Peeso reamers 2, 3, 4 leaving 3 mm of filling material apically. Teeth were temporarily restored with cavite G and stored in enclosed containers while wrapped in moist gauze.

Microleakage was assessed with a fluid transport device using distilled water that was forced through the coronal end of the prepared sample.

Results: The least microleakage was seen in the immediate post space preparation/5 mm filling material group (group 2), followed by the delayed/5 mm group (group 3) and the immediate/3 mm group (group 4). Maximum leakage of the experimental groups was seen in the delayed/3mm group (group 5). A highly significant difference was observed between groups 2 and 3, groups 2 and 4, and groups 2 and 5; groups 3 and 4 and groups 3 and 5. No significant difference was seen between group 4 and group 5.

Discussion: The results of this study indicate that immediate post space preparation was associated with less microleakage than delayed post space preparation. This can be explained by the resin sealer not being set when the post space was prepared, thereby allowing the sealer to re-adapt to the dentinal walls prior to polymerization. In the delayed group, it is likely that the polymerized sealer and core were not able to withstand the rotational forces of the Peeso reamer, resulting in microfractures. The results of this study also show that 5 mm of remaining Resilon provided a significantly better apical seal compared to 3 mm. The authors do not indicate the period of time between post space preparation and microleakage assessment.

LOE: 5
Purpose: To discuss the rationale, indications, limitations, and interpretation of pulp sensibility tests, as well as the value of these tests. Before a certain type of treatment is rendered, information regarding the symptoms, history of the disease, and the results of relevant diagnostic tests must be gathered. Only then can a diagnosis be properly formulated. Pulp sensibility tests, including thermal tests, electric pulp tests, and test cavities can be used to reproduce symptoms, to diagnose the diseased tooth as well as the disease state. However, a major shortcoming with these tests is that they are highly subjective and do not indicate the state of health of the pulp and that in some situations, the responses might be unreliable.

- **Rationale of the tests**
  Innervation of any structure in the body is to provide a warning of damage that is occurring or impending. Thermal tests activate hydrodynamic movement of fluid within dentinal tubules which excites the A-delta fibers. These fibers are fast-conducting producing a sharp localized pain. Continued heat application stimulates the slower conducting C fibers located deeper in the pulp, resulting in dull pain of longer duration. Electric pulp test stimulates the A-delta fibers and suggests the pulp is responsive and at least partially alive. Blood flow in the pulp tissue is necessary for the A-delta fibers to function.

- **Indications of the tests**
  1. Diagnosing pain in the trigeminal area
  2. Determining pulp status of teeth that have been subjected to trauma
  3. Determining pulp status of teeth before restorative dental procedures
  4. Periodically testing teeth that have undergone pulp preservation procedures, such as partial pulpotomies.
  5. Used to help differentiate periapical radiolucencies from normal landmarks
  6. Used to predict potential anesthetic problems in restorative as well as endodontic procedures.
  7. Evaluation of pulp status of transplanted teeth
  8. EPT used after Le Fort type fractures/osteotomies.

- **Limitations of tests**
  1. Tests are subjective and measures only pulp nerve responses and not pulp blood flow (vitality)
  2. Thermal tests only work with open dentinal tubules so may not be effective with older pts.
  3. EPT is less reliable in teeth with immature apices and after trauma
  4. Lack of correlation between results of sensibility test and histological status of the pulp
  5. Especially difficult to administer or inconclusive when used with children
  6. The difference in response from aged pulps vs. younger pulps. Aged pulps have reduced volume, fewer nerve branches that become mineralized.
  7. Difficulties from testing teeth with extensive restorations, pulp recession, and excessive calcification
  8. Lack of reproducibility. Pts might respond differently at different times

- **Interpretation of test results when making a diagnosis**
  The clinician should evaluate the immediacy, the intensity, and the duration of the response. The duration of the response, compared to the baseline may be the most helpful in diagnosing pulpitis.

  **Normal pulp:** produces mild to moderate transient response to cold and EPT. Lasts few seconds after stimulus is removed

  **Reversible pulpitis:** a Thermal stimulus produces sharp pain that subsides as soon as stimulus is removed

  **Irreversible pulpitis:** Thermal changes elicit a sharp pain followed by a dull prolonged ache that might last up to an hour. EPT are of little value in diagnosing irreversible pulpitis.

  **Pulp necrosis:** The blood supply of the pulp cannot be determined with the EPT or thermal tests. However, there is a significant relationship between the lack of response to these tests and pulp necrosis.

  **Pulp necrobiosis:** Is the condition in which some of the pulp has necroses and become infected while the remainder of the pulp is inflamed. Have mixture of symptoms and test results of tooth being necrotic and pulpitis

  **False negatives** (normal pulp that do not respond to tests) can result from significantly calcified or restored teeth, or due to patient being premedicated with sedative or analgesic, have been drinking alcohol, had recent trauma, or immature apex.

  **False positives** (necrotic teeth that responds to tests) possibly due to conduction of EPT to gingival, presence of inflamed pulp tissue in a partially necrotic tooth. Conduction of electrical current via necrotic byproducts, calcified tooth structure, metallic restorations. Also, an anxious pt may produce false positives. It is much rare to have false positive responses to cold tests than to the EPT.
• **Value of diagnostic tests**

When a diagnostic test can be used as a gold standard, determining the accuracy rates of other tests can be determined. Unfortunately, when diagnosing pulp status, a standard is not available to determine the accuracy of other tests as there is no consistently reported relationship between clinical symptoms and histopathological findings and patients experiencing identical clinical symptoms may exhibit different histological states. Heat has a high sensibility but is the least accurate overall of the three common pulp tests owing to its low specificity, whereas the cold test is more accurate than the EPT.

Thermal sensitivity is a sign of pulp inflammation. Usually, cold sensitivity is apparent initially while continuing pulp deterioration leads to heat sensitivity.

Cold tests generally do not injure the pulp but heat tests have a greater potential to cause injury. Cold test can cause pulp degeneration if tissue freezing occurs, but this requires maintaining a very low temperature for long periods of time. Also, if a tooth is going to respond to the cold test, it will in less than 5 sec.

There are various methods of conducting the cold test. One way is with an ice stick. This method has many limitations, such as being inaccurate in adult teeth, posterior teeth, and teeth with secondary dentin. Testing should begin with the most posterior tooth first and advanced forward. False responses may occur from cold water dripping on adjacent teeth. Another disadvantage of ice is that it is not cold enough.

**Refrigerant sprays** are the most convenient, easiest to use, reliable, and reproducible. It produces a lower temperature than the ice stick or ethyl chloride. Green endo-ice (tetra-fluoroethane) is -26.2°C.

**CO₂ snow** reaches -78°C and is placed into a Plexiglas tube. CO₂ snow is consistent, fast, uncomplicated, reproducible, and good to test teeth with crowns or acrylic or porcelain restorations. It is also more effective for testing traumatized teeth. A disadvantage is that it is expensive. CO₂ snow and refrigerant sprays provided more consistent stimuli when compared with cold water and ice.

**Ethyl chloride** is a colorless, flammable gas with a temperature of -12.3°C. It is no longer recommended because it has been found to be less effective than dry ice or DDM.

**Cold water** can also be applied to an entire tooth that has been isolated with a rubber dam. This technique is time consuming but reliable good for testing teeth with crowns and prevents damage to the tooth by excessive temperature changes.

**Heat tests** produce a slower reaction. Heat causes the dentinal fluid to expand, stimulating the A-delta fibers, but also stimulates the C fibers producing a long lasting pain. Pain precipitated by heat usually shows an acutely inflamed or a partially necrotic pulp.

Use of heated gutta-percha stick is difficult in controlling the temperature and should not be placed for more than 5 sec. Reproducibility and testing posterior teeth is difficult.

Frictional heat generated using a rubber cup is preferred for testing teeth with crowns.

**Hot water** bathing an entire tooth with the aid of a rubber dam and is effective to penetrate through crowns and is very accurate.

When conducting these tests, pts should be instructed to raise their hand when they first feel the sensation and lower their hands when the sensation disappears. The operator should wait a few seconds after the stimulus is removed to see whether any pain is elicited before stimulating another tooth. Also, take note that there is refractory period of several minutes before a second thermal stimulation can be applied to the same tooth.

LOE: 1
Topic: Ex vivo cytotoxicity of a new calcium silicate-based canal filling material.

Author: Zhang, W. and et. al.


Reviewed by: Chinchai Hsiao, DMD

Purpose: To evaluate the biocompatibility of iRoot SP® root canal filling material on mouse fibroblasts.

Materials and Methods:

- iRoot SP® (Innovative Bioceramix)- zirconium oxide, calcium silicate, calcium phosphate, calcium hydroxide, filler and thickening agents
- AH Plus® (Dentsply)- epoxy resins, calcium tungstate, zirconium oxide, silica and amines
- ProRoot ®MTA (Dentsply)- tricalcium silicate, dicalcium silicate, tricalcium aluminate, tetra calcium and aluminoferrite
- The above materials were prepared according to manufacturer’s instructions and placed in plastic moulds.
- Each material was divided into two groups - one group was tested immediately after mixing and the other after 24 hrs.
- The fresh and set (24 hrs) specimens were in close contact with mouse fibroblast cells in a filter diffusion test.
- An extract of the set specimens was used for the MTT (3-(4, 5-Dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide, a yellow tetrazole), assay. The assay is used to determine the cytotoxicity of potential medicinal agents and toxic materials, since those agents would stimulate or inhibit cell viability and growth.

Results:

- The filter diffusion test showed that iRoot SP® was slightly cytotoxic when tested as a fresh mixture, but not cytotoxic in a set condition tested after 24 hrs.
- AH Plus® was rated moderately cytotoxic when tested in a fresh mixture and slightly cytotoxic in a set condition.
- ProRoot ® MTA was non-cytotoxic in a fresh state as well as in its set state after 24 hrs.
- The MTT assay extracts of iRoot SP® and ProRoot ® MTA were non-cytotoxic; while AH Plus® extracts were rated slightly cytotoxic.

Discussion: The manufacturer of iRoot SP® (introduced in the market in 2009) claims the material possesses excellent physical and biocompatibility properties. Clinically, sealers are inserted in a fresh mixed stage but even after the setting period it remains possible that leachable toxic substances are released into tissue fluids.

Conclusion: This study showed mild toxicity of the new calcium silicate-based filling material. It is less toxic than the widely used AH Plus® sealer in the two test performed. Freshly mixed iRoot SP® was more cytotoxic than ProRoot® MTA.

LOE:5