Fiberfill

A Fiber Reinforced Adhesively Bonded Endodontic Obturator and Post System

Endodontic therapy provides opportunities to maintain teeth in function and improve the health of the dentition. The long-term prognosis for endodontically treated teeth is greatly influenced by how well the coronal and apical seal are achieved.

Reinfection may result due to coronal leakage through temporary fillings to the apex within 30 days and may be a significant contributing factor to endodontic failure. KHAYAT found that significant coronal dye and bacterial leakage following exposure of sealed root canals to artificial and natural saliva occurred within 30 days through to the apex. Root fracture, another reason for endodontic failure may result from forceful obturation techniques such as lateral or vertical condensation of gutta percha. Lateral and vertical condensation with zinc oxide and eugenol (ZOE) or epoxy sealers, which has been the standard obturation method have demonstrated high fracture rates. MEISTER’s study suggested that excessive force during lateral condensation of gutta percha resulted in 84.38% of the fractures noted in a study of 32 cases of vertical fracture. Whereas, obturation with a single cone of gutta percha and a passive fit with a strong resin sealer resulted in more favorable results.

A fiber-reinforced obturator combined with an adhesive and sealer will be addressed, called Fiberfill (Pentron Clinical Technologies, Wallingford, CT) which strengthens the root structure, decreases apical and coronal leakage and provides anchorage for a restorative core.

Apical and coronal Leakage

Two factors that influence the seal of the canal are the obturation method and the sealer. Single cone techniques were significantly more effective than lateral condensation techniques regarding length of dye penetration. The single cone procedure provided an adequate apical seal against dye penetration, sealing the apical portion passively. Leakage was greatest in the laterally condensed samples with leakage most significant in the first 3 mm from the apex. Carrier delivered gutta percha was found to be superior to lateral condensation technique in terms of both core/sealer ratio and dye leakage. Condensation techniques (lateral and vertical) may remove sealer from the canal walls during the procedure so forceful obturation may not only increase vertical fracture potential but decrease the sealability of the obturation. It was also seen that cold lateral condensation has a higher proportion of specimens with leakage in canals with curvature greater than 20 degrees than in canals with curvatures less than 20 degrees. Therefore, gutta percha delivered to the apex in curved canals had lower leakage. Hence the carrier delivered gutta percha will allow better placement in the canal and improve sealability. The drawback is that the carrier or a portion needs to be removed in order to restore the tooth, possibly disrupting the apical seal in the process.

Although warm lateral condensation resulted in a poor obturation, it was the only thermoplasticized technique analyzed that did not produce significant volumetric changes between 0 min and 30 min. All the other thermoplasticized filling techniques showed significant shrinkage during cooling. Filling of the canal, with warm gutta percha may show
a lower dimensional stability over time then cold gutta percha. Comparison of dimensional stability of warm and cold gutta percha found a much higher permanent deformation (10 x) in warm gutta percha, as well as having a variance in dimensional stability (+5.50 to +7.20).\textsuperscript{13,14}

Endodontic sealers can be divided into different groups based on the main component of the sealer; calcium hydroxide (CaOH), zinc oxide and eugenol (ZOE) and epoxy resins. Significantly less leakage has been reported with calcium hydroxide-containing sealers than with the traditional zinc oxide-eugenol sealers.\textsuperscript{15} Comparison of calcium hydroxide sealer with zinc oxide and eugenol sealer found CaOH has a sealing ability comparable to ZOE and can withstand long-term exposure to tissue fluids without significant leakage.\textsuperscript{16} Both laterally condensed gutta-percha and CaOH as the sealer or with a single master cone and the CaOH paste sealer demonstrated sealing ability.\textsuperscript{17} The greatest dimensional changes with regard to sealers take place within the first 4 weeks. Zinc-oxide-eugenol based sealers generally showed shrinkage ranging from 0.3 to 1 %. The epoxy-based materials, AH 26 and AH 26 silver-free, exhibited a large, initial expansion of 4–5 %. Calcium hydroxide-based materials show only minor variation round a baseline value of –0.14 to +0.19 %. Bacterial penetration may be a real threat from sealers shrinking as little as 1 %.\textsuperscript{18}

Endodontic failure has been associated with leakage within the canal system following obturation. No matter what our intentions are following obturation of the canal system in the tooth, patients may delay restoration of the tooth that has been treated. Financial and time constraints often influence when the final restoration is completed.

Seventy extracted single-rooted mandibular premolars were studied to determine the length of time needed for bacteria present in natural human saliva to penetrate through three commonly used temporary restorative materials and through the entire root canal system obturated with the lateral condensation technique.\textsuperscript{19} The average time for broth contamination of access cavities closed with gutta percha (7.85 days), IRM (12.95 days) and Cavit-G (9.80 days) indicating that even in short periods of time normally seen between visits complete leakage may result.

Another important consideration with regard to the temporary restorations ability to prevent coronal leakage is how the material behaves under mechanical load and thermocycling. Non-adhesive temporary sealers show an increased percentage of marginal breakdown and increased microleakage after thermocycling and loading. There was no significant improvement with increased thickness of the temporary material.\textsuperscript{20–22}

Studies confirm that a sound coronal seal is of paramount importance to the overall success of root canal treatment.\textsuperscript{23} Regardless of the obturation method the best rule is: a properly cleaned, shaped, and obturated tooth should be permanently restored as soon as possible.\textsuperscript{24} But, between visits an adhesive material will prevent leakage and contamination of the canal.

A significantly better seal (in both the apical and coronal directions) can be achieved when using the dentine bonding agent and resin obturation material.\textsuperscript{25} The better the adaption and penetration of the dentinal walls, the less leakage is to be expected along the entire root length.

**Root Reinforcement**

Endodontically treated teeth are under increased possibility of vertical fracture. Most fracture lines occurring in a buccolingual direction. Instrumentation of the root canals significantly weakened the roots.\textsuperscript{26} Letchirakarn found that teeth which had the canal filled with an adhesive material (glass ionomer) resisted vertical fractures. Force that fracture of roots obturated with glass ionomer was significantly higher than those obturated with epoxy resin or ZOE sealer. The results suggested that adhesive sealers strengthen endodontically treated roots and may be used for weak roots, which are likely to be susceptible to vertical root fracture.\textsuperscript{27} Significant strengthening of the root structure could be demonstrated by use of adhesive sealers. This was supported by Trope, who found that bonded resin techniques significantly strengthened teeth against fracture.\textsuperscript{28}

**The FIBERFILL SYSTEM™**

The Fiberfill system consists of an adhesive bonding agent, a light-curable CaOH based resin sealer and a fiber post with an apical terminus of gutta percha. A primer included in the system is a self etching two bottle liquid that allows the sealer to chemically bond to the canal dentin. The primer is a self curing adhesive. The Fiberfill root canal sealer (RCS) is a radiopaque dual cure resin sealer, which contains; UDMA, PEGDMA, HDDMA, and BISGMA resins with silane treated bariumborosilicate glasses, barium sulfate, calcium hydroxide with initiators. The material comes in a two barrel automix syringe. Once mixed it provides a working time of 10–12 minutes and a self cure setting time of approximately 25 minutes. It provides a depth of light cure of 1.7 mm with a final Barcol hardness of 80. The Fiberfill obturator is a resin and glass fiber post with a terminal gutta percha tip. The gutta percha is available in sizes 30, 40, 50, 60, 70 and 80. The canal is instrumented using hand instruments, rotary niti files or a combination and cleaned using
standard irrigation methods. An obturator is selected that matches the final diameter of the canal. The yellow Peeso reamer (included in the kit) is introduced into the canal set either to 5 or 8 mm from the working length. Next, the blue Peeso reamer (also in the kit) is taken to the same depth as the previous reamer. The canal is irrigated, disinfected and dried. A drop of primer A and B are mixed in a dish and applied in the canal with the kits spiral brush. The brush tip is introduced to the depth made by the Peeso reamers. An automix tip is placed on the Fiberfill RCS syringe and the sealer is introduced into the canal with a lentulo or other sealer applicator. The obturator is gently seated to working length allowing excess sealer to be expressed coronally. The dual cure Fiberfill RCS is light cured to stabilizer the coronal portion. Additional primer is applied on the protruding portion of the obturator post and over any dentin and enamel that will be in contact with the core buildup material. A resin core buildup material is then injected around the post filling the coronal portion of the tooth. The material is light cured and ready for either crown preparation or dismissal of the patient. The result is a durable restoration with a resin/fiber reinforced root that is optimally sealed apically and coronally. Leakage was tested with extracted single rooted human teeth. There was significantly less coronal leakage for the Fiberfill specimens then the lateral condensation group.

**Case Presentation**

An 85-year-old female patient presented with carious breakdown of the distal, buccal, lingual and occlusal surfaces of the lower left second premolar (tooth 28). Tooth was asymptomatic and the patient indicated that she “had lost an old filling”. Pulpal exposure was noted on clinical examination and radiographically, a periapical area was observed (Fig. 1). Local anesthetic was administered and isolation was achieved with a rubber dam. Decay was removed and working length established with a number 15 K file and electronic apex locator. Working length was determined to be 22 mm. The canal was instrumented sequentially with size 20 and 25 K files. The canal was then irrigated with 17% EDTA, followed by 5% NaOCL. The canal was shaped and enlarged with K3 files (Kerr Sybron) with a .04 taper sequentially to a size 30. Reirrigation with EDTA and NaOCL to remove any remaining organic matter and smear layer was performed with ultrasonic files. The yellow Peeso reamer was measured to 17 mm (5 mm less the WL) and introduced into the canal. Similarly, the blue Peeso reamer was taken to 17 mm. The canal was then rinsed with 2% chlorhexidine and dried with paper points. A spiral brush was used to apply the primer to the canal walls to the depth achieved by the Peeso burs. A paper point was introduced to remove any excess primer. The Fiberfill RCS was introduced into the canal with a Centrix tip (Centrix) and a lentulo was used to coat the canal walls. A Fiberfill obturator (size 30 with a 5 mm gutta percha apical portion) was gently seated to working length and light cured. A core was constructed using Buildit FR and the post was trimmed with a diamond using a high speed and water to the desired length. The core was shaped to restore the tooth morphology (Fig. 2).

**Conclusion**
So how do we define success in endodontics? Clinical absence of pain was found to not be indicative of endodontic success. A better evaluation may be the absence of continued or new periapical pathology.

CaOH based sealers have been shown to be non-cytotoxic, well accepted by the periapical tissue, bacteriostatic and stable dimensionally following placement. Carrier introduced gutta percha can provide a predictable obturation of the canal with minimal force compared to lateral condensation techniques. It has also been documented that resin reinforcement of the root structure can significantly increase the fracture resistance of the tooth. The Fiberfill system has incorporated these factors into its design and offering a safe, predictable and simple obturation method. Coronal leakage is eliminated by use of an adhesive sealer that is non-irritating to periapical tissue with a pH in the alkaline range thereby creating a bacteriostatic environment in the canal. The obturator, a fiber post (used to restore the missing tooth root part), is adhesively bonded within the tooth during the obturation sealing the coronal portion and providing retention for the core. The gutta percha terminus on the obturator permits retreatment of the canal should it become necessary. In multi-rooted teeth the adhesive and sealer can be used with a single gutta percha cone to obturate the smaller canals.

References