Predictable Endo 102: Why warm and soft is so good

System ‘S’ for injectable or carrier-based GP

By John J. Stropko, DDS

The author has been in private practice and a continuing education student for the past 50 years. The first half was spent primarily teaching school, and the second half in a specialty practice limited to endodontics. On the road to predictability, it became apparent there was a relationship present between root canal treatment, periodontal status, prosthetic and restorative procedures. Each operator has to decide what steps for a more predictable outcome they are willing to trust another to do. This article is an attempt to share some “secrets of success” and perhaps serve as a checklist when the question “How do we do this?” is asked. This article is an attempt to achieve predictability of endodontic treatment. During the earlier years of the past century, several techniques were devised for the obturation of the canal system after removal of the diseased pulp, or necrotic tissue. Some of the most popular were silver points, lateral condensation and Thermafil. Currently there are seven techniques that utilize gutta-percha as the obturation material to choose:

1. Single cone
2. Lateral condensation
3. Carrier-based (Thermafil)
4. Vertical compaction (Pac Mac)
5. Thermoplastic obturation techniques (Obtura)
6. Use of the surgical operating microscope (SOM) for the entire endodontic procedure
7. Coronal seal for the rest of the restoration

The author believes that as long as the gutta-percha is introduced to the apical third of the canal system, pre-warmed and pre-softened, the deformation and adaptation to the canal walls is more predictable, resulting in a better seal that is significantly de-standard-dependent. It has been shown that the pre-warmed techniques (Obtura and Thermafil) produce a better seal than lateral condensation.1 Due to the lack of deformity inherent in root canal temperature, the technique utilizing non-softerned GP are more “sealer-dependent.” The two most popular thermoplastic obturation techniques are the “carrier-based” (e.g., Thermafil) and “direct injection” (e.g., Calamus/Otburia). The pros and cons of each will be discussed, but regardless of the technique used, the shape of the prepared canal system is of utmost importance and must be discussed.

Access and shaping the canal system

In the early ‘70s, Schilder clearly stated the requirements for the proper shape using GP to achieve three-dimensional obturation of the canal system:

1) The root canal preparation should develop a continuously tapering cone shape.
2) It should have decreasing cross-sectional diameters at every point apically and increasing at each point as the access cavity is approached.
3) It should have multiple planes, which introduces the concept of “flow.”
4) The apical opening should be kept as small as practical in all cases.

There were several other requirements which are clinically definitive. Following are a few of them: After placement of the rubber dam and appropriate access is made. Unless the access is large enough for adequate visualization, appropriate instrumentation may be compromised and canals missed. A perfect example is a maxillary first molar; if the access is made as though there was an MB2, it is amazing how many times an MB2 is found. A general rule of thumb is, if you access for it, you are more likely to find it. A proper access will also facilitate the creation of the continuously tapering shape of the canal, necessary for the warm GP technique. Occasionally after caries or old restorations are removed, a “pre-endodontic” restoration may be required to control and maintain a sterile environment until the endodontic treatment is complete. This can usually be accomplished using a bonded composite technique. Shaping should be confined to the anatomy of canal system, following the natural curvatures. Instrumentation beyond the apex is unnecessary and may needlessly enlarge and deform the apical foramen.2

Using the Schilder protocol to achieve the desired shape of the canal system was a time-consuming process. It involved the tedious use of pre-curved files and reamers to follow the anatomic curvatures of the canal. Other requirements that caused some controversy (and still does), besides the size of the access opening, was the need to keep the apical foramen as small as possible, and to maintain patency throughout the entire process. The majority of more recently published research and clinical studies have confirmed the rational for an appropriate access and correct shaping. In the early 1990s technology brought about the introduction of rotary instruments, relieving the operator of considerable time spent creating an acceptable shape. The ProFile rotary bur (Tulsa Dental) with 0.06 taper, was introduced to the profession. Creating the shape necessary for the successful use of the warm obturation techniques was made easier and faster.

By the beginning of this century, numerous designs gradually evolved utilizing varying tapers, active or passive cutting blades, etc. (Fig. 1). At first, the big problem with the rotary files was breakage during use. But modern nickel titanium (NiTi) metallurgy technology has developed more, and more dependable, rotary files. As a result, today the separation of a rotary instrument during use is of virtually little or no concern. It has also been shown that proper shape permits more thorough irrigation and the removal of significantly more debris from the prepared canal system. Disinfecting irrigation should be used between each instrument during the entire shaping process and patency continually maintained with a #40 file. Note: The quantity of irritants used is not as important as the frequency of use. The irrigation protocol, instruments, fluids, etc., are in constant evolution and becoming more effective. However, a clean and sterile environment of the canal system prior to obturation is still the objective.

Irrigation for cleaning the canal system

After shaping is completed, final cleaning can be effectively accomplished by the alternative use of:

1) Warm- to 6- to 7 percent NaOCl 2) 17 percent aqueous EDTA for approximately 30 seconds (smear layer removal)
3) Warm- to 5- to 6 percent NaOCl for further direct and stop action of the EDTA.

The NaOCl can be effectively warmed by placing the irrigating syringes in a beaker of warm water on a heating pad in the background. (Fig. 2). The canals are completely flooded with the desired solution; an EndoActivator bur (Ultradent) attached to a high-speed evacuator. Other...
solutions (hydrogen peroxide, chlorhexidine, 17 percent aqueous EDTA, MTAD, etc.) can also be used appropriately, depending on operator preference. Close observation with an SOM will clearly indicate complete cleaning of the canal system when no debris is flushed out during the irrigation process. During the evacuation with the capillary tip, it becomes apparent if there is a joining of the canal systems within the root. For example, if using the SOM as the MB1 canal is being evacuated and it is noted that fluid is simultaneously being drawn from the MB2 canal, there is a good indication that the system is complicated and does join at some point (Figs. 4a, b).

There are occasions, especially in lower molars, where the nasal root canal system unexpectedly joins with the distal root canal system. On occasion, the maxillary canal system will have the MB1 or MB2 canal system connected to the palatal system. These “surprises” are important to be aware of, before obturation of the canal system, especially when using either carriers or injectable GP. Drying canals with E414+E416

The canal(s) are then dried with 45 percent ethanol (Evereseal available at local liquor store), agitation of the fluids are initiated with an activator for the tissue reaction, then air-dried with the 95 percent ethanol, and then evacuated with the capillary tip. The canal(s) are then heat dried by using a Strophi Irrigator on a dedicated, air-only syringe (ECS), but if a three-way syringe is used, be sure to ex-press all water from the line first (Fig. 5). Next, with a 27- or 30-gauge needle or sidevented needle (Monoject), fit the Strophi Irrigator and heat as necessary, to easily dry the canal system (Fig. 6). Important note: It is essential to regulate the temperature of air so as not to syringe at 1 to 3 psi and use a side-vented or notched needle, to prevent any possibility of un-intentionally forcing air through the apical canal too soon, and achieve with an in-line regula-tor, the Chapman-Huffman reg-u-lar Gauge, Part #17-090-00 (Fig. 7).

As dentists, we are accustomed to a “blast” of air while using the usual air/water syringe rig, but high air pressure to the AgI syringes. When air is regulated and fitted with an appropriate small gauge needle, only a “feel” of air is necessary to create the flow necessary for thorough air drying of the canal. On occasion, one has to direct the air to a sensitive area on himself or herself to be sure the air is even flowing. Just watch-ing the evaporation that occurs within the canal while using the SOM, is enough to convince any operator that there is indeed a flow of air.

There is enough physiologic back pressure of the apical envi-ronment (1.5 mm Hg) to prevent movement of the air past the terminus in the correctly shaped canal. In almost 20 years, with many different doctors using the Strophi Irrigator to “air dry” can-als, the author has only heard of one unfavorable incident. In that one case, the doctor did not use a side vented needle and did not regulate the air pressure to the air syringe.

To repeat, when the Strophi Ir-rigator is used with the properly regulated air pressure (1 to 3 psi) and the appropriate 27- to 90-gauge, side-vented/notched needle is used, there is no chance of forcing air into apical tissues.

Sealer application

To the SOM user, the ineffective-ness of drying the canal with a paper point is soon realized. It is also easy to observe how differ-ently the KERR Pulp Canal Sealer EWT (SyntrolEndo) acts when the canal is in fact not just blotted. After blotting with a paper point, the sealer tends to act like a drop of oil placed on the surface of the canal wall. But when the sur-face is dried, using alcohol and air as described above, the sealer readily spreads onto the canal wall, much like a coat of paint. The complete dryness of the ca-nal to the desired working length is checked with a clean absorbent point that fits to length. This also gives the operator an excellent chance to recheck the working length and dryness of the canal. Any sealer (Kerr EWT, Roth, AH Plus, etc.) can be used as long as the heat of the warm GP does not make a “flash set.” The end 5 mm of a sterile paper point is coated with the sealer of choice and placed into the canal to the working length.

The user chooses Kerr Pulp Canal Sealer EWT, mixed per usual di-men-sions (1:1:1), then “blotchy appearance” the canal (Fig. 8). Only a thin coat of sealer is necessary for lubrication, so very little remains within the canal, while using the evaporation that occurs within the canal while using the SOM, is enough to convince any operator that there is indeed a flow of air.

When a post space is required, the GP can be injected to any level in the canal, but it is better to obturate the entire canal first, so unless absolutely necessary, more coronally in the canal won’t be missed.

Injection of thermo-plasti-cized GP with a Calamus or Obtura

After using the Obtura for more than a decade, the thermo-plasti-cized GP obturation, the author switched to the Calamus when it was introduced in the United States. The last few years, several advantages were noted when comparing the two units (Table 1).

Both units are available in a similar unit, or a dual-channel unit, or a dual-unit, all of which are available with a thermal handpiece for convenience (Figs. 11a-d). The consistent flow of the Calamus unit does make the learning curve quick and easy. This is more than the Obtura, because the relatively large muscle action of squeezing the trigger could vary considerably from patient to patient, or day to day. The author prefers the Obtura because of the triggering action, and the rest time (5 minutes) of the GP can be pre-set for consistency.
Table 1. A comparison of thermo-plasticized GP obturation with Calamus vs. Calamus

<table>
<thead>
<tr>
<th>GP Obturation</th>
<th>Calamus</th>
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<tbody>
<tr>
<td>1. Present to patient</td>
<td>No patient response during obturation</td>
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<tr>
<td>2. No patient response during obturation</td>
<td>No hand fatigue during use</td>
</tr>
<tr>
<td>3. Multiple needle use the norm</td>
<td>No hand fatigue can occur</td>
</tr>
<tr>
<td>4. Barrier protection easy to place</td>
<td>Unit difficult to turn to different angle</td>
</tr>
<tr>
<td>5. Patient often felt a “flash of warmth”</td>
<td>Size verification is critical to the successful obturation process.</td>
</tr>
<tr>
<td>6. “Proper” “squeezes” a larger learning curve</td>
<td>The technique saves the operator the need for a post or a plugger.</td>
</tr>
<tr>
<td>7. Unit difficult to turn to different angle</td>
<td>The carrier is used, the handle is cut at the desired level.</td>
</tr>
<tr>
<td>8. No hand fatigue during use</td>
<td>Excess filling material present at the apex.</td>
</tr>
<tr>
<td>9. Patients often felt apical pressure</td>
<td>The carrier is used, the handle is cut at the desired level.</td>
</tr>
<tr>
<td>10. Generally, very clean to use</td>
<td>The carrier is used, the handle is cut at the desired level.</td>
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Excess filling material

Historically, any time a case was obturated, there was much concern when “pushback” was not observed beyond the apical terminus. Many endodontic failures were blamed on vertical overextension, but in reality the culprit was “under-filled” canal system. As Schilder stated, “You only can fill a canal 100 percent.” If the canal is filled 100 percent, any excess material extrusion beyond the apex is of no consequence. In fact, if the author obturated a canal system and there was no excess filling material, the GP would automatically removed and re-obturated until there was. The point was, “How else could you be sure the canal system was obturated 100 percent unless there was some excess filling material present at the apex?” Cases that have a significant amount of excess filling material but are not symmetrically shaped, cleaned and packed do heal. Over time, the excess material will slowly be resorbed. The biggest fear of the new user of injection or carrier-based GP is, “There will be a great amount of excess filling material and the shape is not symmetrically shaped, cleaned and packed do heal. Over time, the excess material will slowly be resorbed.”
A good example of an easy-to-use temporary is auto-cure Ten-X (Ultradent and Core Poste [Denmat]). CaOH (Ulbradent) is injected into the canal system and covered with a sterile cotton pellet (Fig. 19b). Then Ten-X on 2 is used to condition the access opening (Fig. 19b). After just a few minutes, the auto-cure Core Poste is set completely, the occlusion is ready for any adjustments, to make sure there are no interferences left to irritate the tooth between visits.

On occasion, a patient is unable to keep the appointed return visit and may have to delay his or her return visit for weeks or months. There may be an important change of events in his or her life, or the doctor may also have to change a scheduled visit. If a temporary is placed, such as Cavit, IRM or Tempkut, all control of the bacteriological environment in the canal system is lost. In a completely sealed canal system, the chance of success is the first to become solid mass size (volume), the apical extent is the first to be predetermined if all is done as described. These techniques are easy and fast, fast, fast, fast, predictably for achieving excellent obturation, if all is done as described.

4) In today’s dentistry, the “step back” protocol is to fill the entire canal system. It is self-defeating to do a short-term job in the apical area of the canal system and turn the case over to another to maintain the coronal remainder complete the coronal half of the obturation. As endodontists, we are responsible for the coronal half of the “plug” and forget the importance of sealing “the rest of the system.”

To illustrate this concept, look at the four cases depicted in Figure 18, and then decide which one would have a predictable chance of success. They all have well-done endodontic treatment. However, the patients have all had the entire canal system sealed. A study of twenty-five files that had been root filled and then recrowned many years ago showed that 95 percent of general/restorative dentists did not use a rubber dam while placing a foundation restoration in an endodontically treated tooth. To maximize the predictability of success and avoid possible post-op complications, the “endo-doer” must be responsible for the seal of the entire canal system. He should do his part, and then pass the case to the foundation restoration at the same time.

1) Patient is “in the chair.”
2) Patient is anesthetized.
3) Access is made.
4) Access is sterile for placement of the foundation restoration.
5) The operator has all instruments and materials are easily removed.
6) The tooth has been microscopically enhanced vision.
7) The “endo-doer” knows correct coronal depth of the canal system.
8) There is no chance of contamination of the canal system.
9) Inadvertent perforations are eliminated.
10) The tooth can be “roughed up” without damage to the cusp.
11) The patient has more time to plan for the final restoration.
12) After RCT, doctor knows, within two minutes, the time to schedule for crown prep.
13) On anterior teeth, appointment can be scheduled for placement of a provisional.

It has been shown that coronal leakage can increase the failure rate of end tooth treatment.7 If tooth extraction must be done to all that is possible to prevent it. If multiple visits are required, the doctor should “crown on 2” and “cavit on 2” and maintain sterility. In today’s dentistry, including composite technology, the temporary placed between visits should be a bonded composite.

Another important consideration for controlling post success is the necessity of a post for retention. It is worth repeating, “A post is only indicated if retention of the core is inadequate without it. Posts are only indicated when needed for retention.” The post space must never be shaped to fit the post. Instead, the post must be shaped to fit the existing post space.8 The more radicular substance removed, the weaker the tooth. Posts never strengthen a tooth. Conservation of the radicular structure side to side is to be considered when accessing and shaping the canal system. Only enough tooth substance should be removed to achieve success and desired shape needed to completely disintegrate, clean and obturate the entire canal system. Only then can the post be placed and the correct shape may be difficult if not impossible to achieve. Likewise, if we compromise the shape, the cleaning and obturation will not also be as complete as desired for predictability. The author is amused by anyone who suggests that any access and shaping in the name of tooth conservation. What good does it do if the post fits, the more it flexes, the more micro leakage occurs. If it becomes only a matter of time before the tooth fails. The canal system can be contaminated due to micro leakage, fracture due to lack of radioging strength, or the crown/post/core can break or come out. If a restoration is placed, entirely based on the retention of the foundation restoration, it is not an issue of whether the restoration will fail; it is a matter of when it will fail.8 It is critical that a minimal circumferential ferrule of approximately 2 mm be established for retention of the restoration. A biological width of approximately 2 mm is required for the osseous crest and the internal marginal of the restoration.9 Therefore, a minimum total of 5.5 mm is necessary between the intended cervical margin of the restoration and the osseous crest.

Fig. 20. The Fiberpost has a wide selection of posts with good retention and is easy to use.

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FOR INTERACTION WITH THE AUTHORS FIND THE CONTACT DETAILS AT THE END OF EACH ARTICLE.
tooth is lost to disease? Once the referring doctors are made aware of the favorable benefits that will be derived, it becomes difficult for a conscien-
tious person to not agree to the concept of eliminating untoward possibilities that can lead to fail-
ure of treatment.

Conclusion

The System “S” protocol de-
mands thoroughness in treat-
manship of the entire root canal system. The author uses a Calamus for ob-
stitution, but caries-based techniques of using warm GP can be used with the same de-
gree of success, as long as they are done correctly. System “S” requires a commitment to com-
plete all six steps to avoid the many pitfalls that present them-
selves during treatment of the entire endodontic canal system. A survey of endodontists taken
about nine years ago stated that 36 percent always used an SOM, 50 percent sometimes used it, and 52 percent never used it.12 Hopefully, things have changed. The use of an SOM is essen-
tial for us, as “endo-doers,” to achieve the high level of predict-
ability our current technology al-
loows us to deliver. We only know what we see, and if we don’t see it we don’t know if it. A good ex-
ample is the high percentage of fourth canals (95 percent) that can be found in the maxillary molar segment.

The clinical use of the SOM sig-
ificantly increased the number of canals that were discovered.13

If these canals are not found,
and the operator doesn’t take the time to locate and treat them, the predictability of success will be far less.
It behooves all of us to do everything humanly possible to give our patients dental treat-
ment that will create the health
they expect from our profession.

In general, our current endo-
donotic vision has been directed to treatment of the apical half of the root canal system. It should not be a problem in de-
gregating the basic principles of bonding technology, restorative princi-
pies and post core placement into our new endodontic treatment protocol. We, as a specialty, should be thinking in terms of being responsible for preserv-
ing everything humanly possible to increase the predictability of our treatment. When endodon-
tic treatment fails, it seems like everyone “stands around in a circle and points at one another.”
Adhering to proven princi-
ples eliminates the probability of contamination of the canal sys-
tem by providing a solid founda-
tion for the restorative aspect of the treatment patient.

Obviously, those who are so con-
cerned with the endodontic lack of respect for radiographic structure have not witnessed what often happens to that same tooth when preparing it for a crown. It is im-
perative for the endodontic and restorative to be a team, work-
ing together for predictability, in the interest of the patient.

Our job as “endo-doers” is to learn, become teachers and
educate the patients, staff and doctors we work with, so we can achieve dental health as a team. Let’s not “cave into” the
demands of public convenience or political pressure, but rather be governed by proven dental
principles, so we can achieve predictable endodontic success, saving the teeth our patients are born with, but isn’t that what endo-
donotics is all about?

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Figs. 1. Stain Removal Study Results (UK, 2012).