

Commentary on: Filling Root Canals in Three Dimensions

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I began my endodontic studies in 1962 at Boston University School of Medicine, Graduate Division of Dentistry under the mentorship of Dr. Herbert Schilder. The following is a review of a landmark approach to the management and use of a material that would lead to the three-dimensional obturation of root canal systems (1).

A new paradigm in endodontics was developing in the early 1960s that focused on the belief that the shape of a prepared root canal system could dictate the success of a three-dimensional obturation technique designed to pack the system from the orifice to the apical opening (however that was defined). In addition, Dr. Herbert Schilder's systematic cleaning and shaping regimen (2), stated several principles that led to this predictable method of root canal system obturation. In his landmark publication Dr. Schilder described a technique that utilized (in its simplest forms) heat and pressure to move a material, gutta-percha, some short distance to plug the portals of exit of a prepared root canal system (1). The following is a perspective on that paper.

Dr. Schilder presented a rationale and concept for placing a packing material into a root canal system that would allow the operator to seal the various portals of exit (main root canal exit and lateral or accessory canal exits) with greater certainty of success. Since contemporary endodontics is conceptual by necessity, and since we cannot visualize the completed preparation nor the three-dimensionality of the fill, Dr. Schilder's ability to present advanced concepts in root canal treatment in this and subsequent papers was as important as the concepts themselves.

Dr. Schilder first described the necessity of three-dimensional filling in space parameters that vary infinitely from root canal system to root canal system and can't be easily visualized. He then reviewed the methodology of root canal filling techniques used at the time this paper appeared, including solvent techniques, lateral condensation with non-solvent cements, and the use of silver cones. He completed his paper by introducing the concept of vertical condensation with warm gutta-percha as an alternative method to fill root canal systems three-dimensionally.

He states at the beginning of this section that, "it would seem desirable to fill root canals with a homogenous, inert, dimensionally stable, physiologically acceptable material which could be manipulated with sufficient plasticity to form a permanent cast of the internal configuration of the root canal system." He favored gutta-percha as the filling material of choice in endodontics as he was concerned not only with filling the canal system in its entirety, but also that the material used to accomplish this was as dense as possible throughout its length.

This could be accomplished by warming gutta-percha and condensing it vertically utilizing flat-ended pluggers of decreasing diameter as the apical area was filled. Emphasis was placed on the necessity to shape the system in a manner to create a continuously tapering funnel with its narrowest diameter at the terminus or portal of exit and the widest at the orifice of the system. The importance of this concept cannot be overemphasized as it melded the creation of a preparation with a filling material that could be manipulated in a warmed state, not only to fill the entirety of the system but also to move a bulk of material in the apical five millimeters to plug the main portal of exit.

Other principles described by Dr. Schilder included the proper fit of the gutta-percha core some short distance from the portal of exit so that, when warmed, it could be moved to pack the area with a greater volume of material than could be placed in the unwarmed state. The apical fill, using alternating heat carriers and cold pluggers, created waves of condensation that supplied the impetus to place a denser, greater volume of gutta-percha into a smaller volume of space than could be accomplished with a cold material, and since the greater number of smaller portals of exit (called lateral canals) were located in this area, to also fill these areas. The utilization of pluggers instead of spreaders and their description and use were also presented. This was truly

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a revolutionary concept, as little if any emphasis had previously been placed on designing obturation techniques that address the anatomical complexity of root canal systems. The use of the term "system" made operators aware of the need to fill the space in all of its dimensions, not just in a manner that filled a "root canal". Because Dr. Schilder encountered some degree of dissonance in espousing this technique, he intuitively recognized that, because of the funnel-shape created in the apical area, he could push a greater volume of warmed material into the space than ever before, and the material would not shrink on cooling. He later showed that this was true in a series of five experiments concerning the mechanical and physical properties of warmed gutta-percha (3–7).

The final portion of the paper discussed the apical extent of root canal system fillings. In many respects the importance of this section is more revolutionary in concept than the actual procedure and it triggered much debate. The CDJ was described together with contemporary thought at the time as the landmark that needed to be reached with root canal fillings. Two earlier papers of note had described this landmark (8, 9) and codified in endodontists' minds that nothing should extend past this point. A later review of this concept detailed the fallacy of the older concept (10). Dr. Schilder described his techniques in a manner that suggested that the area to which the fill was placed was somewhat arbitrary and suggested that cleaning, shaping and obturation might be more predictable in its outcome if the operator extended both to the radiographic apex. This would increase the ability of the operator to fill the system to a near 100% of its volume. This would, by necessity of the technique, lead to extension of the filling material past the CDJ and the radiographic apex and introduce foreign material into the periradicular area. Contemporary thinking at that time was that failures would most likely occur in greater numbers, due mainly to the toxicity of the materials and the presence of a foreign body in the periradicular space. However, this aspect of the technique was discussed in relation to the differences in overfilling versus overextension. Because overextension refers only to the vertical dimension of the filling material, ignoring the need for a truly three-dimensional fill, and since root canal systems appear not to be able to be sterilized (notwithstanding the use of CaOH₂ contained in many contemporary medicaments) it is possible if not probable that microorganisms left in the canal system would leech out and reduce healing and long-term success. On the other hand, overextension in the technique described indicates that a root canal system has been filled three-dimensionally throughout its entire length, with sur-

plus of material extending past the portals of exit, therefore microorganisms would be unable to leech out of the system and cause failure.

The importance of these concepts cannot be overemphasized. For the first time, a method of root canal system preparation was described that used a material difficult to control in a manner that filled a space three-dimensionally, resulting in success rates at higher levels than ever before. In the era of the publication of this paper, success rates were spoken of as in the 80% range. Contemporary endodontics reaches success rates in the 95% range or greater, in no small part because of the intuitiveness and thinking of a true giant of endodontists, Dr. Herbert Schilder. In his words: "The final test of a root canal filling is its capacity to seal off the root canal system from the periapical tissues. The tissue compatibility of almost all commonly used root canal filling materials is very high, and for decades bone has been demonstrated to be laid down in close proximity to all of them." These words were true in 1967, and they remain true today. One more giant on whose shoulders many of us have stood, has passed.

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