Explaining Schilder's Five Mechanical Objectives

Dr Raphael Bellamy addresses each of Schilder's Mechanical Objectives from a practical, clinical standpoint

Last issue I discussed the concept of cleaning and shaping the root canal system from a historical perspective and compared this with the goals laid down in present-day endodontics. Schilder outlined the modern concept concisely in his article *Cleaning and Shaping the Root Canal* in 1974 and this is widely regarded as the definitive document on the subject. Within the document he laid down strict mechanical and biological objectives for attaining predictably the goal of successful anatomically generated endodontics. I will discuss the biological objectives in a future issue.

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Before explaining the mechanical objectives and their fulfilment, it is assumed that the operator has prepared an adequate access cavity. In other words, there is straight line access to the body of the canal.

The root canal preparation should develop a continuously tapering cone

This shape mimics the shape of the canals before they undergo calcifications and the formation of secondary dentine. The canal should develop a continuously tapering cone from the access cavity to the apical foramen. This conical shape allows effective cleansing of the canal, as well as allowing hydraulic principles to operate by the restricted flow principle. As flow is restricted by the conical form, compaction of warm gutta percha and sealer generates vertical and horizontal vectors of force that take the path of least resistance, obturating and sealing the apical and lateral foramina. This shape enhances the uses of reamers and files by allowing close contact with the root canal surface. Additionally, appropriate funnelling enhances irrigation, debris removal and tactility and reduces the potential for instrument fracture or transportation by freeing up the instrument in the canal.

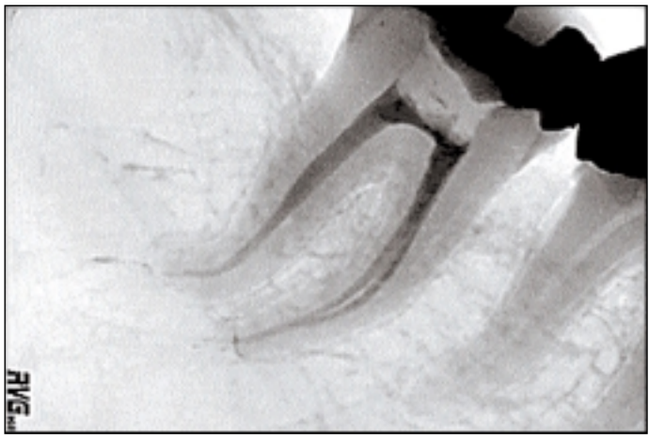
Decreasing cross-sectional diameters at every point apically and increasing at each point as the access cavity is approached

The second objective is a corollary of the first. This shape creates control at every level of the preparation. It facilitates the removal of organic debris coronally by the action of instruments and irrigating solutions. It allows the placement of condensing instruments deep into the root canal preparation to transmit realistic compaction pressures to the warm gutta percha. This potentiates the likelihood of obturating accessory foramina in the apical one third of the system. The sole exception to this second principle is in the case of internal resorption, where adherence to it would greatly weaken the remaining tooth structure.

Decreasing cross sectional diameters at every point apically

...In multiple planes, which introduces the concept of 'flow'

The third objective encourages us to think in the third dimension. As stated in my previous artcle, this is critical in root canal therapy. The root canals within curved roots are similarly curved, and when these are preserved and cleaned the system exhibits natural 'flow'. The greatest problem lies in the apical portion of the canal and the greatest care must be taken to maintain the direction of the curves in this region. Properly prepared root canals will



Multiple planes that introduce the concept of flow

maintain these fine apical curvatures, as should be evident radiographically in the finished case.

Do not transport the foramen

The apical opening should remain it its original spatial relationship both to the bone and to the root surface. The movement or transportation of the apical opening is a common error in root canal preparation that leads all too frequently to chronic root canal discomfort or outright failure in treatment. No straightening is permitted in the apical few millimetres of any canal without severe risk to the outcome of the case. It is common to observe, during surgical endodontics, root canal fillings that radiographically appeared to be within the confines of the root but which have in actuality left the root canal several millimetres short of the apex and have paralleled the root in the adjacent bone. The number of root canals that have left the confines of the original canal but not perforated the root surface are far greater. Success involves the treatment of the naturally existing root canal. Boring pathways in roots may make for good radiographs but it is not a successful therapeutic measure. It is this common and potentially disastrous outcome to which the fourth mechanical object alludes.

Foramen transportation most commonly takes two forms, namely the development of an elliptical or teardrop foramen and an outright root perforation. Since apical foramina are usually found short and to the side of the radiographic apex, repeated passages of reamers and files tend to straighten these delicate passageways and actually enlarge the opening in the direction away from the natural curve of the canal. As the process develops a teardrop opening is created. It ought to be remembered that an inadequate access cavity that restricts the shafts of instruments encourages transportation as well as restrictions in the body of the canal.

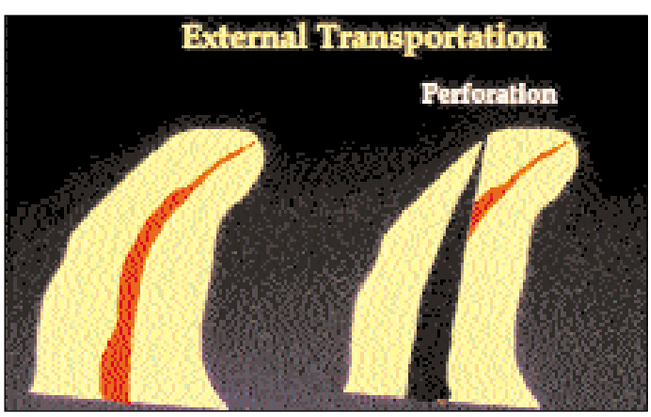
Keep the foramen as small as practical in all cases

Numerous studies confirm that although natural apical foramina are not entirely round, root canals do tend to be rounder in their apical one third. This anatomical reality is of benefit to us, especially in the use of perfectly round rotary instruments. However, we should never fall into the comfort zone of assuming we have cleaned the apical area simply because our instrument has reached the working length. Remember what I said about thinking in three dimensions? We must continue to feel with hand instruments for the ribbons, flags and banners that are the norm of root canal systems.

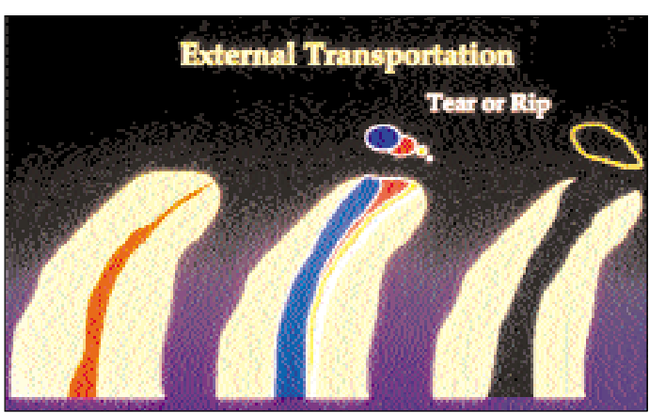
Keeping the foramen as small as practical, not the much misquoted small as possible, restricts the gutta percha in compaction and facilitates compaction. Large vertical and horizontal forces are subsequently generated in the correct shape that will find and seal lateral anatomy. Some of the most difficult cases to obturate are those with enlarged apical openings. Although gutta percha does exhibit excellent rheological properties to facilitate the obturation of the open apex.

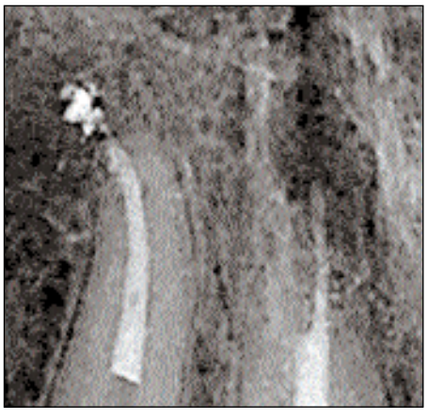
In cases of pulpal necrosis, sufficient enlargement must take place to ensure the cleanliness of the region, but excessive removal of apical dentine and cementum should be avoided. Clearly in a vital, early, pulpitic case the same would not apply. Adherence to the principle that the foramen should be as small as practical places no maximum limitation on its size since this is determined by the clinical situation presented. The large foraminal openings in cases of apical resorption may still be as small as practical. Studies

Perforation



Tear or rip





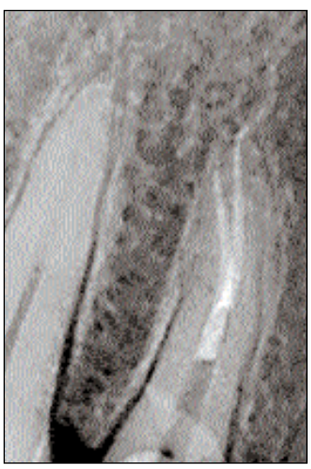
Violation of mechanical objectives four and five (L to R)

by Green (1956) and Kuttler (1955) determined the extent of changes in the apical foramen with increased age. However, the diameters were rarely greater than the 0.3mm to 0.5mm range in any teeth. I baulk at the conversations I hear and cases I see that have been cleaned to and beyond 0.6mm, and even 0.8mm! It is surely no coincidence that these teeth are often symptomatic and weep continually, greatly complicating obturation. Once these sizes are attained by cleaning and shaping, it becomes very difficult indeed to generate a continuously tapering cone to obturate. The goal is to clean but not to enlarge the foramen. If the diameter of a foramen is increased from 0.2mm to 0.4mm, the area of the foramen has increased by four times! Not only does this increase the risk of tearing, it also increases the potential for microleakage.

In summary, the goal is to produce a three dimensional, continuously tapering, multiplaned cone from access cavity to radiographic terminus while preserving foraminal position and size.

It all sounds a bit daunting doesn't it? Well, no, not really, because on close analysis each of the mechanical objectives is a corollary of the one before. Believe me when I say that these objectives are the road map to predictable endodontics. Remember the burglar analogy I mentioned in my previous article? Well the mechanical and biological objectives are the rules that have to be adhered to if the burglar is to remain undetected. If the rules are violated then we run the risk of awaking the sleeping giant. Next issue I will discuss the little known biological objectives of cleaning and shaping.

Keep the foramen as small as practical



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