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Thanks to ever expanding technology, dental professionals are able to treat patients in new and innovative ways. But staying on the cutting edge can be a challenge. That’s what makes the publication you are holding right now so valuable.

For this issue of *roots*, we’ve assembled a collection of articles from some of the most respected names in endodontics. These expert clinicians are sharing their knowledge and expertise with you.

Within this issue you can read reports on using hand files to their full capabilities by Dr. Rich Mounce, and the real state of endodontic instrumentation by Dr. Barry Lee Musikant. In addition, Managing Editor Fred Michmershuizen has written a report on the many offerings for endodontists that were available at the recent ADA meeting in San Francisco.

But there’s even more.

Every issue of *roots* magazine also contains a C.E. component. By reading the article on bioceramic technology by Dr. Ken Koch, then taking a short online quiz about this article at www.DTStudyClub.com, you will gain one ADA CERP-certified C.E. credit. Keep in mind that since *roots* is a quarterly magazine, you can actually chisel four C.E. credits per year out of your already busy life without the lost revenue and time away from your practice.

To learn more about how you can take advantage of this C.E. opportunity, visit www.DTStudyClub.com. Subscribers to the magazine can take this quiz for free and will be emailed an access code after the magazine’s release. If you do not receive the code, please write to support@dtstudyclub.com. Non-subscribers may take the quiz for $20. You can access the quiz by using the QR code on page 6.

I know that taking time away from your practice to pursue C.E. credits is costly in terms of lost revenue and time, and that is another reason roots is such a valuable publication.

I hope you enjoy this issue and that you get the most out of it.

Sincerely,

Fred Weinstein, DMD, MRCD(C), FICD, FACD
Editor in Chief
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Image courtesy of Real World Endo.
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Technology 4 Medicine

I LIKE MY LASERS LIKE I LIKE MY CARS

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Since bioceramic technology was introduced to endodontics, the response has been exceptional. As more and more practitioners have thought through the process, they have been able to see not only the clear benefits of this technology in endodontics, but they are now asking how this technology can be applied to other aspects of dentistry. The application of bioceramic technology has not only changed endodontics both surgically and non-surgically, it has also begun to change the way we treatment plan our patients. As a result of bioceramic technology, we now have the ability to save more teeth in a predictable fashion, while, in addition, improving their long-term prognosis. The option of “saving the natural dentition” is now back on the table.

However, before we investigate specific techniques, we must first ask ourselves, “What are bioceramics?” Bioceramics are ceramic materials specifically designed for use in medicine and dentistry. They include alumina and zirconia, bioactive glass, glass ceramics, coatings and composites, hydroxyapatite and resorbable calcium phosphates. There are numerous bioceramics currently in use in both dentistry and medicine, although more so in medicine. Alumina and zirconia are among the bioinert ceramics used for prosthetic devices. Bioactive glasses and glass ceramics are available for use in dentistry under various trade names. Additionally, porous ceramics such as calcium phosphate-based materials have been used for filling bone defects. Even some basic calcium silicates such as ProRoot MTA (Dentsply) have been used in dentistry as root repair materials and for apical retrofills.

It is important to understand the specific advantages of bioceramics in dentistry and why they have become so popular. Clearly the first reason is related to physical properties. Bioceramics are exceedingly biocompatible, non–toxic, do not shrink, and are chemically stable within the biological environment. Additionally, and this is very important in endodontics, bioceramics will not result in a significant inflammatory response if an overfill occurs during the obturation process or in a root repair.

A further advantage of the material itself is its ability (during the setting process) to form hydroxyapatite and ultimately create a bond between dentin and the filling material. A significant component of improving this adhesion to the canal wall is the hydrophilic nature of the material. In essence, it is a bonded restoration. However, to fully appreciate the properties associated with the use of bioceramic technology, we must understand the hydration reactions involved in the setting of the material.

**EndoSequence BC sealer setting reactions**

The calcium silicates in the powder hydrate to produce a calcium silicate hydrate gel and calcium hydroxide. The calcium hydroxide reacts with the phosphate ions to precipitate hydroxyapatite and water. The water continues to react with the calcium silicates to precipitate additional gel-like calcium phosphate and resorbable calcium phosphates.

\[
\begin{align*}
4 \text{CaO} \cdot \text{SiO}_2 + 6\text{H}_2\text{O} &\rightarrow 3\text{CaO} \cdot 2\text{SiO}_2 \cdot 3\text{H}_2\text{O} + 3\text{Ca(OH)}_2 \quad \text{(A)} \\
2 \text{CaO} \cdot \text{SiO}_2 + 4\text{H}_2\text{O} &\rightarrow 3\text{CaO} \cdot 2\text{SiO}_2 \cdot 3\text{H}_2\text{O} + \text{Ca(OH)}_2 \quad \text{(B)} \\
7\text{Ca(OH)}_2 + 3\text{CaH}_2\text{PO}_3 \cdot \text{H}_2\text{O} &\rightarrow \text{Ca}_6\text{P}(\text{OH})_2 \cdot \text{Ca} \cdot \text{H}_2\text{O} + 12\text{H}_2\text{O} \quad \text{(C)}
\end{align*}
\]
For clinical purposes (endodontics), the advantages of a premixed sealer should be obvious. In addition to a significant saving of time and convenience, one of the major issues associated with the mixing of any cement, or sealer, is an insufficient and non-homogenous mix. Such a mix may ultimately compromise the benefits associated with the material. Keeping this in mind, a new premixed bioceramic sealer has been designed that hardens only when exposed to a moist environment, such as that produced by the dentinal tubules.\(^3\)

But, what is it specifically about bioceramics that make them so well suited to act as an endodontic sealer? From our perspective as endodontists, some of the advantages are: high pH (12.8) during the initial 24 hours of the setting process (which is strongly anti-bacterial); they are hydrophilic, not hydrophobic; they have enhanced biocompatibility; they do not shrink or resorb (which is critical for a sealer-based technique); they have excellent sealing ability; they set quickly (three to four hours); and they are easy to use (particle size is so small it can be used in a syringe).

The introduction of a bioceramic sealer (EndoSequence BC Sealer, Brasseler USA) allows us, for the first time, to take advantage of all of the benefits associated with bioceramics but to not limit its use to merely root repairs and apical retrofills. This is possible only because of recent nanotechnology developments; the particle size of BC Sealer is so fine (less than two microns), it can actually be delivered with a 0.012 capillary tip (Fig. 1).

This material has been specifically designed as a non-toxic calcium silicate cement that is easy to use as an endodontic sealer. This is a key point. In addition to its excellent physical properties, the purpose of BC Sealer is to improve the convenience and delivery method of an excellent root canal sealer, while simultaneously taking advantage of its bioactive characteristics (it utilizes the water inherent in the dentinal tubules to drive the hydration reaction of the material, thereby shortening the setting time).

As we know, dentin is composed of approximately 20 percent (by volume) water, and it is this water that initiates the setting of the material and ultimately results in the formation of hydroxapatite.\(^4\) Therefore, if any residual moisture remains in the canal after drying, it will not adversely affect the seal established by the bioceramic cement. This is very important in obturation and is a major improvement over previous sealers. Furthermore, its hydrophilicity, small particle size and chemical bonding to the canal walls also contribute to its excellent hydraulic properties. But there is another aspect to sealer hydraulicities. That is the shape of the prepared canal itself.

Actually, it all begins with the file. To be more specific, it all begins with the specific preparation created by the file — a constant taper preparation. When using the EndoSequence technique, we can create either a 0.04 constant taper preparation or a 0.06 taper. The real key is the constant taper preparation, because when accomplished it now gives us the ability to create predictable, reproducible shapes. A variable taper preparation is not recommended because its lack of shaping predictability (and its corresponding lack of reproducibility) will lead to a less than ideal master cone fit. This lack of endodontic synchronicity is why all variable taper preparations are associated with the overly expensive and more time-consuming thermoplastic techniques.

Knowing in advance what the final shape (constant taper preparation) will be is a tremendous advantage in creating superior hydraulicities. Then add in the feature of laser-verified paper points and gutta-percha cones, and we now start to develop a system where everything matches (true endodontic synchronicity).

This concept of having everything match is so important because it allows us, for the first time, to perform rotary endodontics in a truly conservative fashion and to be able to use a hydraulic condensation technique. Furthermore, when used in conjunction with the EndoSequence filing system, this becomes a synchronized hydraulic condensation technique. This has tremendous implications for the tooth as evidenced by a recent study published in the Journal of Endodontics.\(^5\) The purpose of this study was to evaluate and compare the fracture resistance of roots obturated with various contemporary filling systems. The investigators (Ghoneim, et al.) instrumented 40 single-canal premolars using 0.06 taper EndoSequence files. The teeth were then obturated using four different techniques. Group I used a bioceramic sealer iRoot.SP (iRoot.SP is BC Sealer in Europe) in combination with ActiV GP cones (Brasseler USA) while Group II used the bioceramic sealer with regular gutta-percha. Group III utilized ActiV GP sealer plus ActiV GP cones and Group IV employed ActiV G sealer with conventional gutta-percha cones. All four groups were obturated using a single cone technique. Ten teeth were left unprepared and these acted as a negative control for the study.

Following preparation and obturation, all the teeth were embedded in acrylic molds and then subjected to a fracture resistance test in which a compressive load (0.5 mm/min) was applied until fracture. Subsequently, all data was statistically analyzed using the analysis of variance model and the Turkey post hoc test.

The results generated were quite remarkable. It was demonstrated that the significantly highest fracture resistance was associated with the ActiV G sealer and the ActiV GP cones. The next highest fracture resistance was associated with the ActiV GP sealer with ActiV GP cones. The least fracture resistance was associated with the bioceramic sealer with gutta-percha. Therefore, if the significantly highest fracture resistance is associated with the ActiV G sealer and the ActiV GP cones, it stands to reason that the next most likely sealer would be one that utilizes iRoot.SP with ActiV GP cones. This is not surprising given the recent studies that have demonstrated that the significantly highest fracture resistance is associated with the ActiV G sealer and the ActiV GP cones.

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I.C.E. article

Bioceramic technology resistance was recorded for both the negative control and Group I (bioceramic sealer /Activ GP cone) with no statistical difference between them. The lowest reported value was in Group IV, which employed ActiV GP sealer in combination with regular gutta-percha cones. The conclusion of this study was that employing a bioceramic sealer (such as BC Sealer) is very promising in terms of strengthening the residual root and increasing the in vitro fracture resistance of endodontically treated teeth. This is a very significant finding, especially regarding the long-term retention of an endodontically treated tooth.

In this particular study, the bioceramic sealer performed best when combined with ActiV GP cones. In fact, bonding will occur between the bioceramic sealer and the ceramic particles in the ActiV GP cones as well as to the bioceramic particles present in the new bioceramic coated cones (BC cones). The technique of achieving a true bond between the root canal wall and the master cone (as a result of creating endodontic synchronicity and advanced material science) is known as synchronized hydraulic condensation.

_Synchronized hydraulic condensation_

The technique with this material is quite straightforward. Simply remove the syringe cap from the EndoSequence BC Sealer syringe. Then attach an Intra Canal Tip of your choice to the hub of the syringe. The Intra Canal Tip is flexible and can be bent to facilitate access to the root canal. Also, because the particle size has been milled to such a fine size (less than 2 microns), a capillary tip (such as a 0.012) can be used to place the sealer.

Following this procedure, insert the tip of the syringe into the canal no deeper than the coronal one third. Slowly and smoothly dispense a small amount of EndoSequence BC Sealer into the root canal. Subsequent to canal obturation, a third scan was made. Scanning of the specimens was performed (Acts 150/130, Varian Medical Systems, Palo Alto, Calif.) with a 180-degree rotation around the vertical axis and a single rotation step of 0.9 degree with a cross-sectional pixel size of approximately 24 μm. All three backscatter pro-

Materials and methods

Sixteen recently extracted human molars were mounted on individual stubs and underwent an initial high spatial resolution CT scan prior to any treatment. Following biomechanical crown-down canal preparation to an apical matrix of 35/0.04 and ultrasonic irrigation with 6 percent sodium hypochlorite, each sample was scanned a second time. Obturation was completed using a single matched gutta-percha cone and EndoSequence BC sealer. The coronal 4 mm of the gutta-percha was thermo-softened and compacted vertically. Subsequent to canal obturation, a third scan was made.

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jections were aligned post-processing with sub-voxel accuracy at 92 percent CI in VG Studio Max 2.1 (Volume Graphics GmbH, Heidelberg, Germany) and manipulated to create regions of interest for each of the scans.

Results

Analysis of volume occupied by sealer in relation to total original canal volumes was found to be extremely high with a mean of 97 percent ± 2.8, much higher than reported previously using studies on canal surface area occupancy of material, with 75 percent of samples occupied at the ≥ 95 percent level (Figs. 2a, 2b).

While the properties associated with bioceramics make them very attractive to dentistry, in general, what would be their specific advantage if used as an endodontic sealer? From our perspective as endodontists, some of the advantages are: enhanced biocompatibility; possible increased strength of the root following obturation; high pH (12.8) during the setting process, which is strongly anti-bacterial; sealing ability related to its hydophilicity; and ease of use. Furthermore, the bioceramic sealer does not shrink upon setting (it actually expands 0.002 percent) and once it is fully set, the material will not resorb.

The cases pictured in Figures 3a through 5c demonstrate the excellence of this technique.

Retreatment of bioceramics

Bioceramic sealer cases are definitely retreatable yet the issue of retreatting these cases (and all the associated misinformation) is not unlike that of glass ionomer. Historically there has been confusion about retreatting glass ionomer endodontic cases (glass ionomer sealer is definitely retreatable when used as a sealer) and, similarly, there has been confusion concerning the retreatability of bioceramics. The key is using bioceramics as a sealer, not as a complete filler. This is why endodontic synchronicity is so important and again, why the use of constant tapers makes so much sense (it minimizes the amount of endodontic sealer thereby facilitating retreatment).

The technique itself is relatively straightforward. The key in retreatting bioceramic cases is to use an ultrasonic with a copious amount of water. This is particularly important at the start of the procedure in the coronal third...
of the tooth. Work the ultrasonic (with lots of water) down the canal to approximately half its length. At this point, add a solvent to the canal (chloroform or xylol) and switch over to an EndoSequence file (#30 or 35/0.04 taper) run at an increased rate of speed (1,000 RPM). Proceed with this file, all the way to the working length, using solvent when indicated. An alternative is to use hand files for the final 2-3 mm and then follow the gutta-percha removal with a rotary file to ensure synchronicity.

The case pictured in Figures 6a through 6d demonstrates the retreatment of BC Sealer.

Bioceramics as a root repair material

We are all familiar with the success of MTA (mineral trioxide aggregate) as a root repair and apico retrofilling material. Furthermore, we realize that because MTA is a modified Portland cement, it has some limitations in terms of handling characteristics. It does not come premixed (and therefore must be mixed by hand), is difficult to use on retrofills, and has such a large particle size that it cannot be extruded through a small syringe. Yet it has a number of favorable characteristics, including a pH of 12.5, which is significantly anti-bacterial. However, in lieu of a Portland cement-based material, we now have available a medical grade bioceramic repair material.

This new repair material is, in fact, the EndoSequence Root Repair material, which comes either premixed in a syringe (just like BC Sealer) or as a premixed putty (Fig. 7). This is a tremendous help not just in terms of assuring a proper mix but also in terms of ease of use. We now have a root repair material with an easy and efficient delivery system. This is a key development and a serious upgrade. This allows many clinicians, not just specialists, to take advantage of its properties.

EndoSequence Root Repair material specifically has been created as a white premixed cement for both permanent root canal repairs and apico retrofillings. As a true bioceramic cement, the advantages of this new repair material are its high pH (pH >12.5), high resistance to washout, no-shrinkage during setting, excellent biocompatibility, and superb physical properties. In fact, it has a compressive strength of 50-70 MPa, which is similar to that of current root canal repair materials, ProRoot MTA (Dentsply) and BioAggregate (Diadent). However, a significant upgrade with this material is its particle size, which allows the premixed material to be extruded through a syringe rather than inconsistent mixing by hand and then placement with a hand instrument.

The Clinicians Report (November 2011) published findings on EndoSequence Root Repair Material. Some of its noted advantages as a root repair material were:

- Easier to use and place than previous similar products.
- Good dispenser (tip/syringe) for easy dispensing.
- Radiopaque.
- Multiple uses for a variety of clinical conditions.
- No mixing required.

Furthermore, their final conclusion was that 95 percent of 19 CR Evaluators stated that they would incorporate EndoSequence Root Repair Material into their practice. Ninety-five percent rated it excellent or good and worthy of trial by colleagues.

Another significant piece of research was published in the Journal of Endodontics, where a research team investigated the antibacterial activity of EndoSequence
Root Repair material against Enterococcus faecalis. The aim of this study was to determine whether EndoSequence Root Repair material either in its putty form or as a syringeable paste possessed antibacterial properties against a collection of Enterococcus faecalis strains. As a standard, they compared the ESRRM to MTA. Their conclusion was, ESRRM, both putty and syringeable forms and white ProRoot MTA demonstrated similar antibacterial efficacy against clinical strains of E. faecalis.

This research again validated earlier studies that found ESRRM (putty) and ESSRM (paste) displayed similar in vitro biocompatibility to MTA. Additionally, other studies found that the ESRRM had cell viability similar to Gray and White MTA in both set and fresh conditions.

Even more significant research was published (January 2012) concerning bioceramics in general. In a comparison of endodontic sealers, it was demonstrated that in various moisture conditions within a root canal, iRoot SP (EndoSequence BC Sealer) outperformed all other sealers. The conclusion of the study was, “Within the experimental conditions of this in vitro study, it can be concluded that the bond strength of iRoot SP to root dentin was higher than that of other sealers in all moisture conditions.”

As mentioned previously, the bioceramic material to use in surgical cases is the EndoSequence Root Repair Material (RRM). The ESRRM is available in two different modes. There is a syringeable RRM (very similar to the basic BC Sealer in its mode of delivery) and there is also an RRM putty that is both stronger and malleable. The consistency of the putty is similar to Cavit G. The RRM in a syringe is obviously delivered by a syringe tip but the technique associated with the putty is different.

When using the putty, simply remove a small amount from the room-temperature jar and knead it for a few seconds with a spatula or your gloved hands. Then start to roll it into a hotdog shape. This is very similar to creating similar shapes with desiccated ZOE or SuperEBA (Bosworth). Once you have created an oblong shape, you can pick up a section of it with a sterile instrument and use this to deliver it where needed (Fig. 8). This is an easy technique for apico retro fills, perforation repairs, and even for resorption defects. After placing the putty into the apical preparation (or defect) simply wipe with a moist cotton ball and finish the procedure.

The cases pictured in Figures 9a to 10c are evidence of how beautifully this technique works. These cases are so significant because they clearly demonstrate the extraordinary healing capability of bioceramics, when used as a repair material. The X-rays display amazing healing and bone fill in the mandible in less than six months.

_Pulp capping with bioceramics_

One of the other significant benefits of having bioceramics come premixed in a syringe (EndoSequence Root Repair Material) is the ability for all dentists to now easily treat young patients in need of pulp caps or other pulpal therapies (e.g., pulpotomies). Previously, many specialists considered MTA to be the ideal material for a direct pulp cap because it did not seem to engender a significant inflammatory response in the pulp.

Unfortunately, due to price concerns and the difficulty of placement, this methodology was not universally accepted. However, we now have a true bioceramic material (ESRRM) that not only works well, but is easier to use. It is much easier. Hopefully, this will lead to an increased use of bioceramics in our pediatric patients and help these patients save their teeth. All dentists can benefit from this upgrade in technique.

The technique itself for a direct pulp cap with the bioceramic root repair material is as follows: Isolate the tooth under a rubber dam and disinfect the expo-

_Figs. 6a–10c Cases demonstrate healing and bone fill in less than six months. (Clinical X-rays/Provided by Allen Ali Nasseh, DDS MMSc)
sure site with a cotton ball and NaOCl. Apply a small amount of the RRM from the syringe or, take a small amount of the RRM putty from the jar, and place this over the exposure area.

Then, cover the bioceramic repair material with a compomer or glass ionomer restoration. Following the placement of this material, proceed with the final restoration, including etching if required. Single-visit direct pulp capping is now here.

_Future directions and prosthodontic applications_

The future promises to be even more exciting in the world of bioceramics. There will be new fast-set [eight to 10 minutes] repair materials introduced, as well as a special bioceramic putty for pediatric use (primary teeth). We have also seen the melding of bioceramic technology into the world of prosthodontic cements, with the introduction of Ceramir Crown & Bridge (Doxa Dental). It is easy to predict that we will see more applications of this technology in different aspects of dental medicine.

In this article, we have introduced a new bioceramic sealer (EndoSequence BC Sealer) that when combined with coated cones offers an exciting new obturation technique (Synchronized Hydraulic Condensation).

The properties associated with the new bioceramic sealer also allow us to be more conservative in our endodontic shaping which ultimately leads to the preservation of natural tooth structure. Surgical applications have also been introduced, and cases shown, which demonstrate the remarkable ability of bioceramics. The future is bright for bioceramic technology and even more exciting for dental medicine._

References

7. Lloyd A., Personal communication.

_About the authors_

**Dennis Brave, DDS**
left, a diplomate of the American Board of Endodontics and a member of the College of Diplomates, received his DDS degree from the Baltimore College of Dental Surgery, University of Maryland and his certificate in endodontics from the University of Pennsylvania. In endodontic practice for over 25 years, he has lectured extensively throughout the world and holds multiple patents, including the VisiFrame. Formerly an associate clinical professor at the University of Pennsylvania, Brave currently holds a staff position at The Johns Hopkins Hospital. Along with having authored numerous articles on endodontics, Brave is a co-founder of Real World Endo.

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**Ken Koch, DMD**
received both his DMD and certificate in endodontics from the University of Pennsylvania School of Dental Medicine. He is the founder and past director of the New Program in Postdoctoral Endodontics at the Harvard School of Dental Medicine. Prior to his endodontic career, Koch spent 10 years in the Air Force and held, among various positions, that of chief of prosthodontics at Osan Air Force Base and chief of prosthodontics at McGuire Air Force Base. In addition to having maintained a private practice, limited to endodontics, Koch has lectured extensively in both the United States and abroad. He is also the author of numerous articles on endodontics. Koch is a co-founder of Real World Endo.

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Despite wide global acceptance of rotary nickel-titanium (RNT) canal enlargement, hand files remain central to endodontic practice. It can be argued persuasively that proper canal negotiation and glide path creation are key ingredients to successful long-term treatment, along with adequate and appropriate irrigation, canal preparation, coronal seal, etc. Simply stated, after the preparatory steps of straight-line access and removal of the cervical dentinal triangle with orifice openers, if the canal is not properly negotiated and a glide path prepared prior to RNT enlargement, cleaning and shaping procedures cannot be optimal.

This article was written primarily for the general dentist. It describes stainless-steel (and, to a lesser degree, nickel titanium) hand files, reciprocation and their clinical application. This article is intended to be a clinical "how to" article, not a literature review, hence a lack of extensive references. The endodontist is encouraged to compare their treatment methods with those described here. The Mani product line of files is described primarily because these files are used daily by the author. Examples of equivalent files are provided alongside of Mani products throughout the article for comparison.

There are myriad hand-file designs, applications, materials and manufacturing methods. In recent years, multiaxis grinding machines have provided advancements of true clinical consequence, especially with regard to file flexibility and cutting ability. Given the wide diversity of available designs and features, it is impossible to discuss the design, clinical use or precautions required for every hand file on the market. Neither barbed broaches nor balanced force technique will be discussed.¹

Introduction: Appreciating the unseen dimension

Hand files allow the clinician to manually “feel” the unseen dimension in canal anatomy beyond what radiographs alone can illustrate. Specifically, by virtue of hand-file resistance to apical advancement, the clinician can, by tactile feel, determine...
the curvature, calcification, length, the anatomy of the MC, and if iatrogenic events may have occurred. Only cone-beam technology comes close to providing the tactile information provided by hand files (Planmeca).

Such tactile information helps determine treatment strategies prior to shaping. Astute RNT use has, as its foundation, intimate canal knowledge first by hand files. Forcing RNT files to length without adequate hand-file negotiation and a glide path is the harbinger of file fracture, canal transportation and inadequate cleaning and shaping.

_AHand–file applications, differentiation and general use principles_

Hand files differ based on the following (among other attributes):

1) Material of manufacture (carbon steel, stainless steel, nickel titanium, among several other less common materials).

2) Taper (0.02 tapered, variable tapered, greater tapered).

3) Initial cross-sectional design before manufacture (triangular, square, rhomboid, among other initial shapes).

4) Final cross-sectional design.

5) Corrosion resistance.

6) Handle design and material used for the hand file.

7) Tip sizes (of the individual instrument).

8) Progression of tip sizes across the spectrum of a given set of instruments.

9) How the cutting flutes are produced (twisting, grinding, among other manufacturing methods).

10) Tip design (active, non cutting, partially cutting).

11) Whether the file is reciprocated, watchwound (K files), rotated (K reamers), or used with a pull stroke (H files).

12) Helix angle, rake angle, cutting angle (if different from the rake angle) number of flutes (as well as flute width, depth and number).

13) Possible variability of the cutting angle along the length of the file.

14) Linear length of the cutting flutes.

15) In addition to the attributes above, hand files are designed to be stiff versus flexible, aggressive cutting versus less aggressive, finishing files versus bulk shaping files, among other general classifications.

_BPrinciples for maximizing hand file effectiveness_

The use of hand files is based on several universal assumptions. These assumptions are:

A) Optimal visualization of the access preparation, ideally through the surgical microscope (Zeiss, Global Surgical).

B) Optimal radiographic evaluation of the tooth prior to access preparation including where necessary, cone-beam visualization. For those without CBCT technology, having two or optimally three different pre-operative radiographic angles will provide the best possible visualization of canal anatomy short of a CBCT scan.

C) Straight line access.

D) Removal of the cervical dentinal triangle prior to hand-file exploration.

E) Copious irrigation at every stage in the procedure, especially rinsing debris from the access preparation before hand files are inserted.

F) Pre-operative evaluation of the estimated and expected true working length, final taper and master apical diameter.

G) Curved files negotiate curved canals more effectively than straight ones. The EndoBender pliers (Axis/Sybron) are an effective instrument to place the needed curvature onto hand files. Generally, in canals that have been ledged or transported, placing an acute, 3- to 5-mm curve onto the apical portion of the hand file is beneficial. Multiple insertions of curved hand files to bypass blocked and transported canals (especially ledges) are the rule, not the exception. Alternatively, if no transportation has occurred (the canal is untouched or easily negotiable) the clinician can curve the file in their fingers without an EndoBender.

H) Canals should always be negotiated with hand files prior to using RNT files. Even if the clinician uses a RNT glide path creator (PathFile, Dentsply Tulsa or PreShapers, SpecializedEndo), the canal should be first negotiated by hand to assure patency. Clinician preference dictates whether a glide path should be created by hand files or RNT files.

I) In the view of the author, hand files are single use disposable instruments as they dull rapidly during clinical function.

J) The use of nickel–titanium hand files is a matter of personal preference. While some clinicians desire the flexibility and shape memory of nickel–titanium hand files, others do not. It should be noted that nickel–titanium hand files are available with controlled memory, a proprietary thermo mechanical process in which nickel–titanium hand files lose their shape memory yet retain their flexibility.2–4

K) The principles of canal preparation must be observed, irrespective of the methods utilized to achieve these principles (i.e., hand-file canal enlargement and/or RNT enlargement or a combination of these methods). These principles are to:

1) leave the canal in its original position (simply enlarge it as described here);

2) leave the minor constriction (MC) of the apical foramen at its original position and size;

3) create a tapering funnel with narrowing cross-sectional diameters from orifice to apex;
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4) create a master apical taper that optimizes irrigation and obturation hydraulics, and yet causes no iatrogenic events (strip perforation, canal transport unnecessary dentin removal — and does not leave the tooth at risk of long-term vertical fracture).

**General classes of hand files**

**Files primarily designed for canal negotiation**

In calcified canals, hand-file stiffness is an attribute. Mani D Finder files are representative of this class and are especially useful for early negotiation of calcified canals. The D finders have a D-shaped cross section. Some files utilize carbon steel in manufacture and/or possess atypical tip sizes to facilitate negotiation. Stiffness can be attributed to either the file’s design (Mani D Finders) or the use of carbon steel and/or a combination of carbon steel and a modified design (Pathfinder CS, Axis/SybronEndo) (Fig. 1).

**K files**

Generally, K files have a three- or four-sided configuration with more spirals than K files. Smaller reamers are generally square in cross section. Larger reamer sizes are generally triangular. The angle between the cutting flutes and long axis of a reamer is most often in the 10- to 30-degree range. Reamers are used in rotation, unlike K files. Hand-file rotation is associated with less canal transporta-

**K Reamers**

Mani K Reamers are three-sided and contain fewer spirals than K files. Smaller reamers are generally square in cross section. Larger reamer sizes are generally triangular. The angle between the cutting flutes and long axis of a reamer is most often in the 10- to 30-degree range. Reamers are used in rotation, unlike K files. Hand-file rotation is associated with less canal transporta-

**K files**

Generally, K files have a three- or four-sided configuration with more spirals than K reamers. Mani K Files are four-sided. Overall, K files are the most ‘universal’ hand files covering the greatest number of clinical indications.

K files are not as flexible as hand files designed specifically for flexibility (such as the Mani Flexile files discussed below) or nickel-titanium hand files. K files are used with a watch-winding hand motion and can be reciprocated (as described below). The angle between the cutting flutes and long axis of a K file is generally in the 25- to 40-degree range. Lexicon K Files are an additional example of another commercially available K file (Dentsply Tulsa).

**H files**

H files (Mani H Files as well) have conical spirals ground into them. They are used on the pull stroke for gross removal of canal contents in the coronal third and in retreatment. H files should not be rotated due to fracture risk inherent in their design. The angle between the cutting flutes and long axis of an H file is generally in the 60- to 65-degree range. It is not advisable to use H files near the MC. The MC can be transported easily if H files are used at or beyond the MC. Clinically, aside from transporta-

**Hand files of accentuated and variable taper**

Mani Flare Files are more tapered than standard hand files — 0.05 taper compared to 0.02 taper. They are used to prepare tapered canals for doctors who hand file the entire preparation among other more specialized uses such as verifying taper before cone fit.

Accentuated taper is also available with nickel-titanium GT Hand Files. ProFile 0.04 Hand Files are 0.04 tapered and come in a variety of tip sizes, again in nickel titanium. ProTaper Universal Hand Files feature the ProTaper variable taper design in shaping and finishing files in various lengths (all of the above are manufactured by Dentsply Tulsa).

**Flexible Files**

Mani Flexile Files are triangular in cross section. Files with a triangular cross section are more flex-

**Flexible Files**

Mani Flexile Files are triangular in cross section. Files with a triangular cross section are more flex-

**Additional files in this class are Lexicon FlexSSK Files (Dentsply Tulsa). These files are also available in medium sizes (12, 17, 22, etc.).**
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Aggressive cutting files
Mani RT files (possessing a parallelogram cross section) and a 71-degree cutting angle, making them more aggressive relative to many of the other files included here. RT files would be used primarily by doctors who are hand filing the entire canal in conjunction with other hand files (Fig. 4).

Nickel titanium files
GT Hand Files (made of nickel titanium) are available in various tapers and tip sizes (Dentsply Tulsa). Lexicon FlexNTK Files are made of nickel titanium and come in various tip sizes while maintaining a constant taper. As mentioned above, clinician preference dictates whether a flexible stainless steel file is more desirable than a nickel titanium hand file.

Medium sizes, K, H and reamers
Mani provides K Files, H Files and stainless-steel reamers in medium sizes (12, 17, 22, 27, etc.). ProFile Series 29 Stainless Steel 0.02 Hand Files have a constant 29 percent increase in tip size in 0.02 taper. Use of medium sizes avoids the dramatic increase in tip diameter with increasing tip sizes, especially between a #10 and a #15 hand file (a 50 percent increase in size of the #15 relative to the #10 hand file).

Safe-ended hand files and reciprocation
Mani SEC O files are available in an H and K file variety. Both are "safe-ended," as they do not cut on their tips. The Mani SEC O K File is ideal for reciprocation. SEC O H files (and H files in general) are not reciprocated (Figs. 5,6).

Reciprocation is a very safe technique, whereby the clinician can use a reciprocating handpiece attachment to replicate manual hand file watch winding. Clinically, reciprocation is used after the canal has been negotiated to the TWL and reciprocation proceeds with the first file that binds at TWL. In this article, the terms TWL and MC are synonymous. The purpose of reciprocation is to save time, reduce hand fatigue and prepare a space into which RNT files can subsequently be inserted with minimal torque stresses (prepare a glide path).

Reciprocation is inherently safe. It is difficult to fracture hand files when this technique is used appropriately. Fracture or iatrogenic misadventure generally occurs when the files are inappropriately placed (well beyond the MC), the wrong type of hand file is reciprocated (H) and/or the speed is grossly exaggerated above the recommended levels.

Reciprocating handpiece attachments fit onto an E-type coupling and can be powered at 900 rpm, for example at the 18:1 setting on an electric endodontic motor.

To initiate reciprocation, the file is left in the canal at the TWL and the reciprocating handpiece is placed over the file (the file is inserted into the head of the reciprocating handpiece and is held there while reciprocating). The attachment reciprocates the file clockwise and counter clockwise — for example, with a 30-degree clockwise and 30-degree counterclockwise movement. These attachments do not rotate the file a full 360 degrees — in contrast to how RNT files are powered. Different reciprocating handpieces may have variations on the degree of clockwise or counterclockwise rotation and possibly include a vertical amplitude.

The Synea W&H-62A is an example of a reciprocating handpiece (MounceEndo) attachment with a 30-degree clockwise and 30-degree counterclockwise motion. Reciprocation is the technique and file motion utilized in the Wave One canal preparation system (Dentsply Tulsa).

Clinically, using the SEC O K File as an example, the SEC O K File is placed to the TWL, the attachment placed over the file and reciprocation commences as described above. The file is reciprocated for 15 to
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Tuesday, 11.27.2012
10:00 - 5:30
Dr. Chris Glass, Dr. David Evans, Dr. Ron Jackson, Dr. David Hoexter - Various Dental Topics

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30 seconds, using a 1- to 3-mm vertical amplitude movement. Clinically, the file will become less tightly bound as the canal is enlarged.

If, for example, a #08 SEC O K file is the first file that binds in the canal at TWL, this file is reciprocated. Once the #08 SEC O K File is reciprocated, the canal will now accept a #10 SEC O K file to TWL. The #10 SEC O K File is reciprocated. Once reciprocation is complete, the canal will allow a #15 SEC O K File to reach the TWL. Once the canal is enlarged to approximately the size of a #15 or #20 hand file, the canal is ready for RNT enlargement.

Aside from glide path creation, this technique is especially helpful in early enlargement of calcified canals, especially the MB2 canal of upper molars. Reciprocation is also valuable for rubbing out iatrogenic ledges. Once the hand file can negotiate around the ledge, it is left in place and reciprocated as suggested above.

It is not advised to place a hand file in a reciprocating handpiece attachment and try to move the file apically while powering the file. While such a motion will work some of the time, it can accentuate ledges and other canal transportations and increase the risk of file fracture.

Integration of the glide path with early RNT shaping

If the clinician is using RNT shaping methods, the decision must be made to move either crown down, step back or possibly use a hybrid of the two strategies. While a comprehensive discussion of such RNT strategies is beyond the scope of this article, it has value to mention that judicious initial removal of restrictive dentin at the point of greatest root curvature (especially in complex cases) is essential to minimize subsequent iatrogenic events. Caution is advised. RNT fracture is a risk when the wrong taper and tip size RNT file (for example, a 0.02/20, 0.03/20, or 0.04/20 file such as the MounceFile CM (controlled memory) can minimize the risk of subsequent fracture that may otherwise result in moving directly to a strict crown down approach around such a curvature. Fracture risk is minimized with the removal of restrictive dentin along the curvature through use of the instruments above (Figs. 7,8).

Alternatively, instead of using the MounceFile, the clinician can make an equivalent enlargement through the curvature using a 0.04/25 Twisted File (Axis/Sybron) or similarly sized RNT file.

This article, written for the general dentist, has described common attributes of hand files, their clinical use, reciprocation, and integration of glide path preparation with initial shaping procedures. Emphasis has been placed on interpreting tactile feedback and avoidance of iatrogenic events. Your feedback is welcome._

References

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- RDH @ YDC
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While the quality of endodontic instrumentation and obturation are generally based on our final mesio-distal X-rays, we must not believe for a moment that such an X-ray is necessarily a predictable or even accurate reflection of a job well done even when the results look excellent. I say this today because research over the past several years has clearly established that canals are often quite oval, deviating significantly from the conical shapes we most often associate with thorough instrumentation and obturation (Figs. 1, 2).

In this regard, the inadequacy of rotary NiTi in shaping such canal configurations is established by a plethora of research articles. The use of rotary NiTi aggravates incomplete shaping by its need to stay centered at all times within the canal. It takes little imagination to realize that an instrumentation system that requires constant centering lest it be more prone to separation, is not going to cleanse what are often the buccal and lingual extensions of highly oval canals. To further compound inadequate debridement, single instrument NiTi instrumentation systems have been introduced that have also been clearly shown via micro CT scans to miss removing more than 50 percent of the tissue in the canals (Fig. 3).

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and to a lesser extent asymmetric NiTi reciprocation creates an incentive in the dentist to prepare canals conservatively with an increased incidence of debris left behind. Recent research has now demonstrated an increased occurrence of dentinal micro-fractures when the canal walls are exposed to NiTi instruments generating full arcs of motion.\textsuperscript{3-6} It should also be noted at this time that both hand instrumentation and engine-generated movement not resulting in full arcs of motion are not associated with the development of micro-fractures.

In short, 20 plus years after the introduction of rotary NiTi and its close cousin asymmetric reciprocation, we are becoming more aware of the limitations imposed by these systems including modification of technique to prevent separation, non-deviation from centered canal preparations leaving debris in the wider extensions of oval canals to again prevent separation, the understanding that NiTi instruments of increasing tip size and taper are not only more prone to breakage, but are more likely to create dentinal micro-fractures.

Given the aggressive marketing of these instruments and their universal adoption by our dental educational institutes, it is imperative that we understand what these instruments cannot predictably and safely do and what alternatives exist that can produce a safer and more thorough result. The research has clearly established that apical canal preparations must be to at least a 30 and preferably a 35 to provide sufficient space for effective irrigation. Given the insecurities of the present NiTi systems such apical preparations will be a rarity particularly in curved canals of molars.

The first improvement in instrumentation must be the elimination of instrument breakage as a source of concern. If breakage can be eliminated, the challenges to the dentist doing endodontics is now limited to negotiating and widening the canal without distortion, a far easier task when separation is no longer a worry.

It’s one thing to talk about the benefits of non-separation, but exactly how is this accomplished when it is common wisdom that breakage is something that anyone doing endodontics must contend with? The fact is that if the movement of the instruments are limited to a tight arc of motion manually and do not exceed a 30-degree arc of motion when engine-generated, the elastic limit of the instruments will not be exceeded and the instruments will remain intact. The twin factors that lead to the separation of NiTi instruments are torsional stress and cyclic fatigue, both generated by high degrees of rotation. Substitute 30-degree reciprocation for full arcs of rotation and the instruments will remain intact even when used at 3,000–4,000 cycles per minute.

The consequences of no longer needing to be concerned about instrument separation are several:

1) The earliest instruments can be used aggressively against all the walls of the canals including the thin isthmuses that may be present either between canals or the extensions of oval canals.

2) The instruments can be used several times until they become dulled. They need not be replaced after one use because the downside to over usage is dullness not breakage, a fact that relieves a good deal of gastric distress while dramatically reducing the cost.

3) The canals are widened to a minimum of 35 in accordance with the research that shows how such preparations correlate to superior irrigation.

What we have not mentioned up to now is just what design is optimal. Here we deviate from the traditional use of K-files, substituting K-reamers through a 10 and then relieved K-reamers (Fig. 4) starting with the 15 and continuing on with instruments of this design for the complete shaping proce-
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1) K-reamers have half the number of flutes with a flute orientation that is twice as vertical producing less engagement along length.

2) Used with the same watch-winding motion as K-files, the reamers will immediately shave dentin away from the canal walls because the more vertical orientation of the flutes puts them more or less at right angles to the plane of motion, similar to what occurs when shaving with a safety razor that is on a T. The same way a blade at right angles to the plane of motion produces smooth skin, it will effectively shave dentin away from the canal walls. The traditional use of K-files results in the engagement, not the removal of dentin, until the pull stroke is employed. Yet these same horizontally oriented flutes on a K-file have a high potential to impact dental debris when being introduced into the canal.

3) Having half the number of flutes compared to a K-file, the reamer is less work hardened making it more flexible. The incorporation of a flat along its entire working length makes it still more flexible. That along with its reduced engagement along length allows it to negotiate curved and tortuous canals with far less resistance than a K-file will encounter, allowing the canal to be shaped to the proper dimensions in significantly less time. It should also be noted that the creation of the glide path is where blockages, ledges and loss of length most frequently occur, a direct result of the poor K-file design. This is far less likely to happen when using the reamers both unrelieved and relieved either manually or in the 30-degree reciprocating handpiece.

4) A system based on the design of a relieved reamer and utilized in a way that minimizes the amplitude of motion is best made of stainless steel. NiTi requires only a small extension of distortion beyond the elastic limit to produce a breakage. Stainless steel will work under far more distortion before it separates, making it a more practical metal than NiTi.

5) Stainless steel can be pre-bent to adapt to any canal configuration. NiTi, in most preparations snaps back to the straight position with a tendency to shape curved canals to the outer wall. Those preparations of NiTi that can record a bend are so flexible that they can easily lock apically while rotating or reciprocating coronally. There is a downside to being too flexible.

6) The greater stiffness of stainless steel means it must not be used in rotation, but has no limitations when used with a short arc of motion either generated manually or in the reciprocating handpiece. The greater hardness of stainless steel means the instruments will retain their cutting edge far longer than NiTi. Considering the fact that these instruments should be used at least six times before replacement, the retention of a sharp blade is a decided advantage.

It is an easy task to enumerate the advantages of the reamers over that of K-files and the subsequent use of NiTi. The proof, however, is in the pudding and a recent example of the work that we produced in our office will illustrate the advantages gained from their usage.

Figures 5–7 show a maxillary molar that was prepared apically to a minimum of 35, 1 mm back to a 40 and the implementation of the single NiTi instrument we use in reciprocation, the 25/06 to blend in the middle and apical thirds. The dimensions of the preparation were in accordance with the research that recommended a 35 for effective irrigation.

From the outset, using the thinnest 06 reamers, all the walls of the canals were shaped by the reamers’ vertically oriented blades. If we are serious about removing the tissue in the thin isthmus extensions that often exist, we must address them at the very beginning of instrumentation when instruments are the thinnest.

The reamers far more easily negotiate curved canals than K-files and if increasing resistance is encountered are pre-bent and negotiated manually around any tortuous canal present. A combination of superior dentinal shaving, less initial engagement and increased flexibility give the reamers the ability to provide the dentist with excellent tactile perception, letting him know exactly when an instrument may require pre-bending.

With the ability to be pre-bent and limited to a short arc of motion, the stainless-steel reamers both unrelieved and relieved can adapt to any situation that may be encountered. The result is not only one that looks good in the mesio-distal plane, but is cleansed three dimensionally to a degree that assures cleaner canals and superior obturation while leaving the walls of the canal defect free.

Editorial note: A complete list of references is available from the publisher.
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ADA holds meeting in San Francisco and offers plenty for endodontists

The American Dental Association held its 153rd Annual Session and World Marketplace Exhibition in San Francisco in October. For endodontists, the meeting offered an opportunity to learn from leaders in clinical practice, research, academia and industry. There was also plenty of new technology to discover.

In the lecture halls, Dr. L. Stephen Buchanan, one of the featured speakers at the meeting, presented an all-day lecture and a hands-on course. In the lecture, “The Art of Endodontics: Everything Has Changed but the Anatomy,” attendees were able to see fresh clinical footage shot with a state-of-the-art HD1080p video camera. The images were painted onto a screen at a resolution that resembled looking through a microscope. Attendees were able to see new procedures, such as rotary negotiation, guided-bur access preps, single-file GTX shaping, single-cone backfilling and many more. Most of the video clips were chosen from recent clinical cases.

In Buchanan’s hands-on course, attendees were able to use the new TrueTooth™ 3-D printed training roots.
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replicas, available from Dental Education Laboratories, were used in a hands-on course.

**Fig. 3.** Nick Snow, left, and Sarah Tzdepski of Coltene show off some of the company’s products for endodontic treatment.

**Fig. 4.** Meeting attendees crowd the aisles of the ADA exhibit hall in San Francisco.

**Fig. 5.** Dr. L. Stephen Buchanan’s new TrueTooth 3-D printed training replicas, available from Dental Education Laboratories, were used in a hands-on course.

replicas, available from Dental Education Laboratories. The replicas allow dentists to practice again and again until they get consistently good results with a given technique in a given anatomic challenge. There is also a patent-pending process for these TrueTooth replicas to have simulated pulp tissue that dissolves with sodium hypochlorite irrigating solutions.

On the exhibit hall floor, many companies offered products and resources of value to endodontists.

Wykle Research offered new products for endodontic treatment. Calasept irrigation needles are dual-side-vented, luer-lock irrigation needles that are designed to provide for safe and effective irrigation. The dual side vents optimize cleansing of canals, creating a “swirl” effect. The closed tip safely protects the apex. Also available from Wykle are new Calasept color-coded irrigation syringes that are designed to eliminate risk when using multiple irrigation liquids.

Jordco, a company that continues to refine its product line, offered a wide range of products for treatment, diagnosis, organizing, storage, safety and convenience. For treatment, the Endoring II hand-held endodontic assistant, EndoGel endodontic lubricating gel, e-Ruler endodontic file measuring instrument and Pure Bond Dispensers bonding agent and composite dispenser were available. Also popular was the Jordco e-Foam endodontic foam and the FileCaddy bulk file storage system.

Taken together, the offerings comprise what the company calls the Jordco System. The system works on the premise that Jordco products complement each other and work in concert from diagnosis through all phases of treatment.

Coltene Endo showcased its HyFlex CM NiTi files with Controlled Memory, which the company says are up to 300 percent more resistant to cyclical fatigue compared with other NiTi files, which substantially helps reduce the incidence of file separation. According to Coltene Endo, HyFlex CM NiTi files have been manufactured utilizing a unique process that controls the material’s memory, making the files extremely flexible but without the shape memory of other NiTi files.

For those who prefer not to use rotary files, Essential Dental Systems (EDS) offered its Endo-Express reciprocating handpiece and its SafeSiders, designed to eliminate the fear of fracture associated with crown-down systems and the typical shortcomings of the step-back process.
Wykle Research has announced the release of two new Calasept Endo products, which it distributes for Nordiska Dental of Sweden, the manufacturer of Calasept and Calasept Plus.

Calasept Irrigation Needles are high-quality, double-side-vented, luer-lock irrigation needles that optimize the cleansing of canals, creating a "swirl effect." The needles are available in 27 g or 31 g, in packs of 40 needles.

Features include the following:
• Bendability
• Luer-lock hub
• Sterile and disposable
• Designed for ease in cleaning roots
• High-quality stainless steel

Calasept Irrigation Syringes are 3 ml luer-lock, single-use syringes. They are color coded to eliminate risk when using multiple irrigation liquids. They are available in packs of 20 syringes, 10 white and 10 green.

Features include the following:
• High-quality, three-part syringe
• Color coded
• Luer lock

These new products complement Wykle's popular Calasept line, which includes Calasept and Calasept Plus calcium hydroxide paste for temporary filling of root canals, which is sold in packages of four syringes with 20 needles. Calasept EDTA is 17 percent EDTA solution. Calasept CHX is 2 percent chlorhexidine solution for irrigation. Both solutions are packaged with a luer adaptor for easy filling of syringes.

Wykle Research distributes Calasept Endo products by Nordiska Dental, a Swedish manufacturer of Dental supplies. Wykle Research and Nordiska Dental will continue to provide new endo products.

For more information, contact Wykle Research at (800) 859-6641 or visit the company online at www.wykleresearch.com.
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- contact info (email address please)
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must be combined into one Microsoft Word document. Please do not submit multiple files for each of these items. In addition, images (tables, charts, photographs, etc.) must not be embedded in the text document. All images must be submitted separately, and details about how to do this appear below.

If you are interested in submitting a C.E. article, please contact us for additional instructions before you make your submission.

Text length

Article lengths can vary greatly — from a mere 1,500 to 5,500 words — depending on the subject matter. Our approach is that if you need more or less words to do the topic justice, then please make the article as long or as short as necessary.

We can run an extra long article in multiple parts, but this is usually discussing a subject matter where each part can stand alone because it contains so much information. In addition, we do run multi-part series on various topics. In short, we do not want to limit you in terms of article length, so please use the word count above as a general guideline and if you have specific questions, please do not hesitate to contact us.

Text formatting

Please use single spacing and do not put extra space between paragraphs. We also ask that you forego any special formatting beyond the use of italics and boldface, and make sure that all text is left justified.

If you would like to emphasize certain words within the text, please only use italics (do not use underlining or a larger font size).

Boldface should be reserved for article headlines, headers, and subheads please.

Please do not "center" text on the page, add special tab stops or use underlines in your text as all of this must be removed manually before layout. If you require a special layout, please let the word processing program you are using help you to do this formatting automatically rather than doing it manually.

If you need to make a list or add footnotes or endnotes, please let the word processing program do it for you automatically.

There are menus in every program that will help you apply all sorts of special formatting.

Image requirements

Please number images consecutively by using a new number for each image. If it is imperative that certain images are grouped together, then use lowercase letters to designate the images in a group (i.e., Fig. 2a, Fig. 2b, Fig. 2c).

Insert figure references in your article wherever they are appropriate, whether that is in the middle or end of a sentence, but before the period rather than after. Our preference is to have figure references noted in the appropriate place within the text, as it helps the readers to orient themselves when moving through the article. In addition, please note:

- We require images in TIF or JPEG format
- These images must be no smaller than 4 x 4 inches in size at 300 DPI
- Images should be 1 MB in size each

If you have an image that is greater than 1 MB, please do not bother "sizing it down" to meet our requirements, but send us the largest file size available. The larger the starting image is in terms of bytes, the more leeway the designer has in terms of resizing the image to fill up more space should there be room available.

Also, please remember that you should not embed the images into the body of the text document you submit. Images must be submitted separately from the textual submission.

You may submit images through a zipped file via e-mail, unzipped individual files via email or post a CD containing your images directly to us (please contact us for the mailing address as this will depend upon where in the world you will be mailing them from).

Please do not forget to send us a head shot photo of yourself that also fits the image requirements noted above so that it can be printed along with your article.

Abstracts

An abstract of your article is not required. However, if you choose to provide us with one, we will print it in a separate box.

Contact info

At the end of every article is a contact info box with contact information along with a portrait photo of the author.

Please note at the end of your article the exact information you would like to appear in this box and format it according to the previously mentioned standards.

A short bio (50 words or less) may precede the contact info if you provide us with the necessary text.

Questions? Comments?

Please do not hesitate to contact us for our International C.E. Magazine Author Kit or if you have other questions/comments about the article submission process:

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