ENDO TRIBUNE

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Endodontic file design is crucial

By John T. McSpadden, DDS

Why do we need to know anything about instrument design?

The capabilities of files made of the same material are entirely dependent on design. Successes of file design and, to a considerable extent, clinical success are determined by how effectively the design addresses various canal anatomies. Clinical expertise and ergonomics can greatly depend on understanding file design and how the design functions.

Although radiographs portraying desired canal shapes are often used to illustrate the capabilities of a particular type of file, the desired canal shape can be attained with virtually any set of files, provided they are used properly. How efficiently the shape can be attained is another matter.

No one aspect of file design is indicative of the file's overall usefulness. Optimizing one design feature can compromise another benefit. For instance, greater file flexibility is usually accompanied with greater susceptibility to torsion failure. Considerations for design effectiveness include the following: cutting ability, operational fatigue, stress concentration points, operational torque, torque at breakage, flexibility, screwing-in forces, ability to maintain the central axis of the canal and tip mechanics.

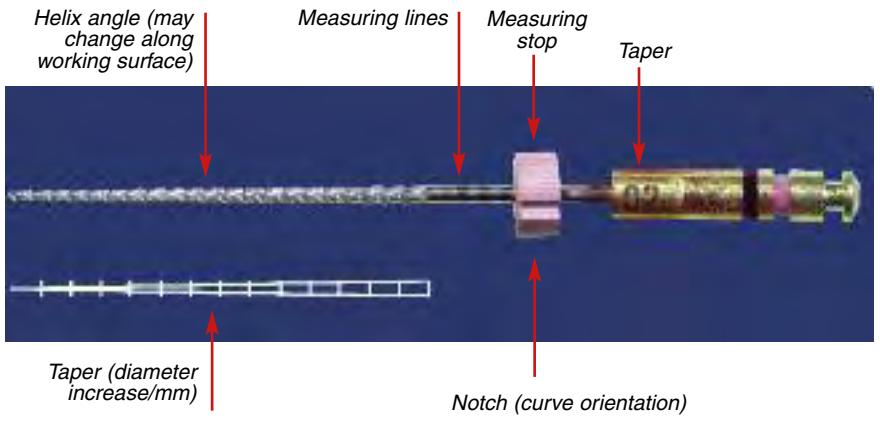

Fig. 1: A size 25 file with a 0.02 taper.

What are the basics of file design?

• ***The taper:*** Standardized dimensions played an important role at the time they were instituted for providing the needed consistency for hand instruments, but were soon seen as limitations for rotary instrumentation. One of the first standards for file design to be eliminated was file taper. The taper is usually expressed as the amount the file diameter increases each millimeter along its working surface from the tip toward the file handle. For example, a size 25 file with a 0.02 taper would have a 0.27 mm diameter 1 mm from the tip, a 0.29 mm diameter 2 mm from the tip, and a 0.31 mm diameter 3 mm from the tip (Fig. 1). Some manufacturers express the taper in terms of percentage, in which case the 0.02

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AAE energizes endo experts in Orlando

Annual meeting welcomes ample 4,000 attendees

By Fred Michmershuizen, Online Editor

Nearly 4,000 dental professionals gathered at the Gaylord Palms in Orlando, Fla., for the 2009 Annual Session of the American Association of Endodontists. The meeting, held April 29 through May 2, offered specialists and GPs a chance to learn about the newest products and techniques. From the opening session, when a military drill instructor motivated attendees to get on their feet and reach for new heights, to the closing celebration, featuring a rousing performance by the Beach Boys, attendees seized the opportunity to get revitalized.

Wearing a bright orange tie, Dr. Louis E. Rossman, president of the AAE, officially kicked off the meeting Thursday morning with a vigorous and heartfelt speech that was fitting for this year's theme — "Engage, Energize, Educate." Rossman's message to endodontists was clear: it's all about confidence.

"Not everyone in dentistry recognizes the advances in our specialty, and many teeth that could be saved are simply being yanked," Rossman said. "It is our duty to get out and deliver a message of confidence."

It is the responsibility of endodontists, he said, to emphasize the benefits of saving natural teeth and to trumpet the advances in the specialty that continue to make root canal therapy ever more beneficial to the patient. At the same time, he said, endodontists should immerse

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Dr. Richard E. Mounce lectures on obturation during his theater-in-the-round Master Clinician Series presentation. (Photo by Fred Michmershuizen, Online Editor)

AD

AAE board supports political advocacy with donation

Uniting on behalf of the endodontic specialty, the board of directors of the American Association of Endodontists (AAE) recently joined the American Dental Political Action Committee as members of its Capital Club. The initiative, currently the only one of its kind among dental specialties, demonstrates through monetary contributions the AAE's conscious commitment to political outreach.

Dr. Louis E. Rossman

The donation was made during the American Dental Association's Annual Session in San Antonio, Texas, held Oct. 15–19. Each of the 21 members of the AAE board made contributions at the ADPAC booth at the same time. To become members of the ADPAC's Capital Club, individual members must donate a minimum of $200, significantly higher than the standard $49 ADPAC contribution.

"Endodontists are motivated to support ADPAC because it not only advocates for the interests of organized dentistry but also for the health and well being of our patients," said then-AAE President Dr. Louis E. Rossman. "In these turbulent times, it's essential to identify political candidates who share our views on improving the dental profession and serving the public in key areas, such as advancing science and working to keep dental care affordable."

ADPAC's purpose is to fund candidates for federal office who understand the importance of dentistry and are committed to the nation's oral health. By contributing to ADPAC, individual dentists have the chance for a significant, collective impact on the political forces that affect their professional lives.

"ADPAC is thrilled to have the AAE Board of Directors team together in our quest to advocate dental political action constantly," said Dr. Roger W. Triftshauser, ADPAC chair. "Joint efforts, such as this, are imperative in strengthening ADPAC as the leader in health care PACs."

The AAE strongly encourages all its members to become more active in organized dentistry and their local communities through its Step Up! program.

The program is the catalyst for involving endodontists in leadership and community service, bolstering the AAE as the premier endodontic organization in the nation. Step Up! participants display a dedication to service and strength of character that builds the public's and profession's view of the specialty.

To learn more about the Step Up! program, *visit www.aae.org/stepup*.

(Source: AAE)

EndoVision can help specialists utilize benefits of the Economic Stimulus Bill

On Feb. 17, President Obama signed into law the Economic Stimulus Bill, officially titled the American Recovery and Reinvestment Tax Act of 2009. The act ambitiously aims to improve the quality and access to health care in this country while reducing medical errors, cost and waste and promoting more and better research.

Some confusion exists as to how the stimulus bill affects dentists and dental specialists. EndoVision's aim is to help you understand the far-reaching opportunities and requirements you must begin to consider now. The way you as professionals — as well as your team — record health-care information is about to change profoundly.

The EMR/EDR/EHR Mandate — What is it?

The HITECH Act (the Health Information Technology for Economic and Clinical Health Act) allocates $19.2 billion for programs promoting the adoption of Healthcare IT.

Under HITECH, use of a certified EMR (Electronic Medical Record), an all-digital, SOAP-structured record of your patients' health-care information, will be required for all health-care professionals by 2015.

All health-care providers in the United States will need to purchase and install the necessary software and hardware, implement it properly and use it in a meaningful way.

Are dentists, dental specialists covered by HITECH?

Yes. Anyone who administers health care — all doctors, auxiliaries and anyone who prescribes medication of any kind — is covered equally.

The confusion over whether dental professionals are or are not covered arises from a crucial ambiguity: dentists are never specifically mentioned in the bill language.

The bill does say all health-care providers and physicians are covered. It then references the reader to look at the Social Security Act for definitions of those terms.

In that referenced document, in the definition list of what a "physician" is, there is unambiguous language stating a "physician" includes any "doctor of dental surgery or of dental medicine who is legally authorized to practice dentistry…"

HHS' 'Carrot & Stick' approach to EMR Adoption: What are the schedule and key provisions?

• ***The Carrot*** — Subsidies will begin to be paid out in 2011 and then will be paid out annually through 2015. The allocation of the subsidies favors early adoption in that practices will miss a subsidy for any year that they have not yet implemented, and the amounts of the subsidies decrease each year.

• ***The Stick*** — For those who have not implemented a certified EMR by 2015, penalties will mount starting in 2016: Health and Human Services (HHS) will lower a doctor's Medicare/Medicaid fee schedule by 1 percent per year. What the "stick" will be for dentists is not clearly stated in the bill and the national coordinator of Office to the National Coordinator is charged with determining that by the end of 2009.

How can EndoVision help you?

EndoVision® software, available from Henry Schein Practice Solutions, currently contains the only complete and true SOAP EMR embedded into a PC-based practice management software product. Its EMR is created under a special and exclusive endorsement agreement with the AAOMS. Further, developers are seeking certification. EndoVision offers a clear path to profitable business management and mandate compliance.

Remember: to take advantage of all of the subsidies, you must implement and meaningfully be using EMR by next year. EndoVision reps are ready to help! To begin the process, call (800) 680-6902 or send e-mails to EMRQuestions@henryschein.com.

(Source: EndoVision)

ET Corrections

Endo Tribune strives to maintain the utmost accuracy in its news and clinical reports. If you find a factual error or content that requires clarification, please report the details to Sierra Rendon, managing editor, at s.rendon@dtamerica.com.

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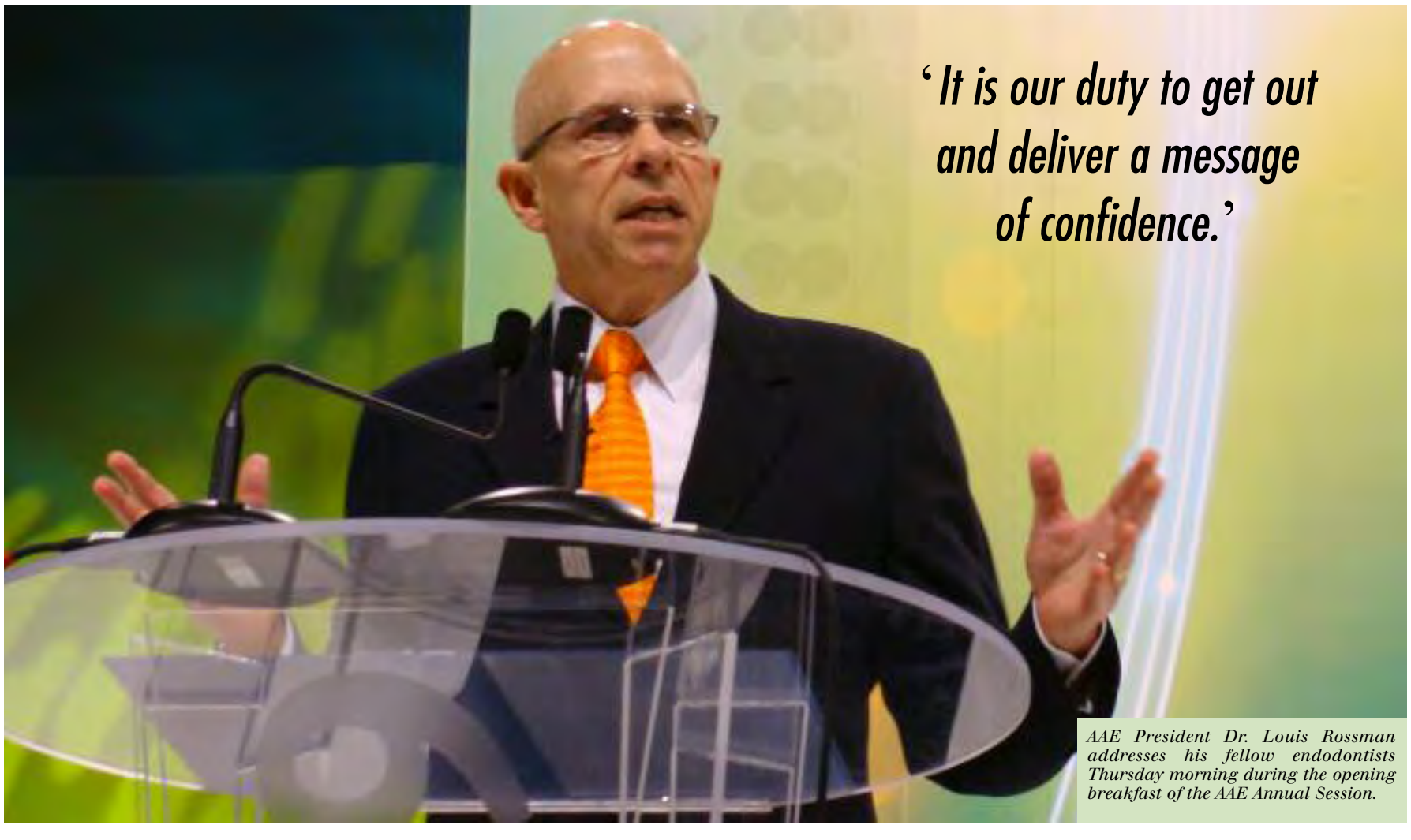

AAE President Dr. Louis Rossman addresses his fellow endodontists Thursday morning during the opening breakfast of the AAE Annual Session.

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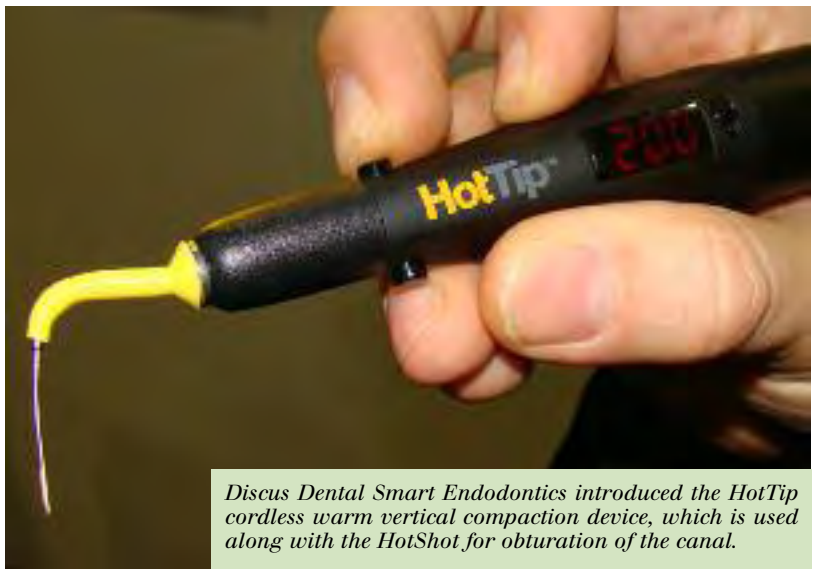
themselves in knowledge of implants, so that when a decision has to be made between root canal therapy and an implant, the endodontist can offer an opinion based on credible knowledge. Ultimately, he said, it is all about what is best for the patient.

After the opening session, attendees crowded into the exhibit hall featuring products from scores of exhibitors. Many companies launched new products.

Discus Dental Smart Endodontics introduced its LightSpeedCRX and LightSpeedMRX instruments, which are designed to clean and shape the coronal third and middle third of the canal. These new files complement the LightSpeedLSX files, which are used for the apical third. Discus also unveiled its new HotTip cordless warm vertical compaction device, which is used along with the HotShot for obturation of the canal.

Many attendees visited the SybronEndo booth to investigate the company's Twisted Files, which are now available in new sizes. There was also a great deal of interest in the RealSeal One bonded obturation system available from Sybron.

Of course, before the canal can be cleaned, shaped and filled, the practitioner needs to see what he or she is up against. Companies offering magnification equipment showcased the latest in microscopes and loupes. Seiler Precision Microscopes offered demonstrations on the prototype for a brand new model of scope with many new fea-



Discus Dental Smart Endodontics introduced the HotTip cordless warm vertical compaction device, which is used along with the HotShot for obturation of the canal.

Dr. Jerry Glickman, who teaches and practices in Dallas, is incoming president of the AAE. 'It could not be a better time to be an endodontist. The future is bright,' he told Endo Tribune.

Dr. Hamid Abedi tells meeting attendees about the new Anesto anesthetic delivery device, which was unveiled by Innovadontics.

Photos by Fred Michmershuizen, Online Editor

Those who visited the SybronEndo booth at the AAE meeting wanted to check out the new sizes of Twisted Files.

Jordco's eRuler was one of the many innovative products available on the exhibit floor at the AAE meeting.

Seiler Precision Microscopes offered demonstrations on the prototype for a brand new model of scope with many new features and benefits.

tures and benefits.

A new anesthetic delivery device — the Anesto — was unveiled by Innovadontics, a distributor of products manufactured by W&H. Designed to be quick and easy, the Anesto allows anesthetic to be delivered first to the soft tissue and then to hard tissue. The developer of Anesto, Dr. Hamid Abedi, was on hand to offer demonstrations.

There were also many educational offerings at this year's AAE meeting. For the first time, the AAE presented a Master Clinician Series, featuring live, nonsurgical endodontic techniques in a theater-in-the-round setting.

Series presenters included Dr. James K. Bahcall, Dr. L. Stephen Buchanan, Dr. Giuseppe Cantatore, Dr. Richard E. Mounce, Dr. Ali A. Nasseh, Dr. Clifford J. Ruddle and Dr. G. John Schoeffel.

In all, more than 100 educational sessions and more than 197 hours of continuing education credits were offered. An all-day Pre-Session Symposium, "Integration of Advanced Surgical Procedures in Your Endodontic Practice," was held on Wednesday.

During a luncheon on Saturday, Dr. Rossman passed the reins of leadership over to incoming AAE President Dr. Gerald N. "Jerry" Glickman. Before he officially took office, Dr. Glickman told Endo Tribune he is looking forward to working with the AAE board and its members during the coming year to help advance the future of the specialty.

"It is our goal as endodontists to work with general dentists, other specialists, our dental schools and the public to continually address the need to preserve the natural dentition as long as possible," Dr. Glickman said. "Ultimately, it is about saving the natural tooth."

The meeting concluded Saturday evening with a "Celebrate Orlando!" event, featuring a performance by the Beach Boys at the Hard Rock Live at Universal Studios.

The 2010 AAE Annual Session will be held April 14–17 in San Diego.

AD

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taper becomes a 2 percent taper. Historically, as an ISO standard, a file was fluted and tapered at 2 percent for 16 mm, but now files incorporate a wide variation of lengths and tapers of working surface.

Changing from one taper to another during instrumentation can be one of the most important methods of limiting file engagement and, therefore, file stress is limited. If a smaller tapered file is inserted into the preparation of a larger tapered canal, only the apical portion of the file initially becomes engaged. Conversely, if a larger tapered file is inserted into a smaller tapered canal, only the coronal portion of the file initially becomes engaged.

- ***The flute:*** The flute of the file is the groove in the working surface used to collect soft tissue and dentine chips removed from the wall of the canal (Fig. 2). The effectiveness of the flute depends on its depth, width, configuration and surface finish. The surface having the greatest diameter that follows the groove (defined as where the flute and land intersect), as it rotates, forms the leading (cutting) edge, or the blade of the file that forms and deflects chips from the wall of the canal and severs or snags soft tissue. Its effectiveness depends on its angle of incidence and sharpness. If there is a surface that projects axially from the central axis as far as the cutting edge, between flutes, this surface is called the land (sometimes called the marginal width).

The land reduces the screwing-in tendency of the file, reduces transportation of the canal, decreases the propagation of microcracks on its circumference, gives support to the cutting edge and limits the depth of cut.

Its position relative to the opposing cutting edge and its width determine its effectiveness. In order to alleviate frictional resistance or abrasion resulting from a land, some of the surface area of the land that rotates against the canal wall may be reduced to form the relief. The angle that the cutting edge makes with the long axis of the file is called the helix angle and serves to auger debris collected in the flute from the canal.

- ***The core:*** The core (Fig. 3) is the cylindrical center part of the file having its circumference outlined and bordered by the depth of the flutes. The flexibility and resistance to torsion is partially determined by the core diameter.

The core taper and total external taper can be different, and the relative diameter of the core, compared to the file's total diameter, may vary along its working portion in order to change the flexibility and resistance to torsion. The importance of the ratio of core diameter to total diameter is often overlooked in predicting a file's susceptibility to failure and can be different for each file size of the same series.

Rake angle and cutting angle

If the file is sectioned perpendicular to its long axis, the rake angle (Figs. 4a, 4b) is the angle formed by the leading edge and the radius of the file. If the angle formed by the leading edge and the surface to be cut (its tangent) is obtuse, the rake angle is said to be positive or cutting. If the angle formed by the leading edge and the surface to be cut is acute, the rake angle is said to be negative or scraping.

However, the rake angle may not be the same as the cutting angle. The cutting angle, effective rake angle, is a better indication of the cutting ability of a file and is obtained by measuring the angle formed by the cutting (leading) edge and the radius when the file is sectioned perpendicular to the cutting edge.

In some instances, as with some Quantec files, a file may have a blade with a negative rake angle and a positive cutting angle. If the flutes of the file are symmetrical, the rake angle and cutting angle will be essentially the same. Only when the flutes are asymmetrical are the cutting angle and rake angle different. Both angles may change as the file diameters change and may be different for file sizes.

The pitch

The pitch of the file is the distance between a point on the leading edge and the corresponding point on the adjacent leading edge along the working surface, or it may be the distance between points within which the pattern is not repeated. The smaller the pitch or the shorter the distance between corresponding points, the more spirals the file will have and the greater the helix angle will be and, generally speaking, the greater propensity for the file to "screw in" the canal will be.

Most files have a variable pitch, one that changes along the working surface, because the diameter increases from the file tip toward the handle and the flute becomes proportionately deeper resulting in a core taper that is different from the external taper.

Some instruments, such as the Quantec and K-3 files, have asymmetrical cross-sectional designs in which case the pitch may be considered to be the distance between points that the pattern is not repeated.

The cutting angles, helix angles, external and core taper may vary along the working surface of the file and the ratios of these quantities can vary between instruments of the same series. Any change of any of these features can influence the file's effectiveness or its propensity for breakage as it progresses into the canal space and can account for some files to act uncharacteristically when compared to files that have different dimensions in the same series.

Functions of lands

Lands are the surfaces of files that

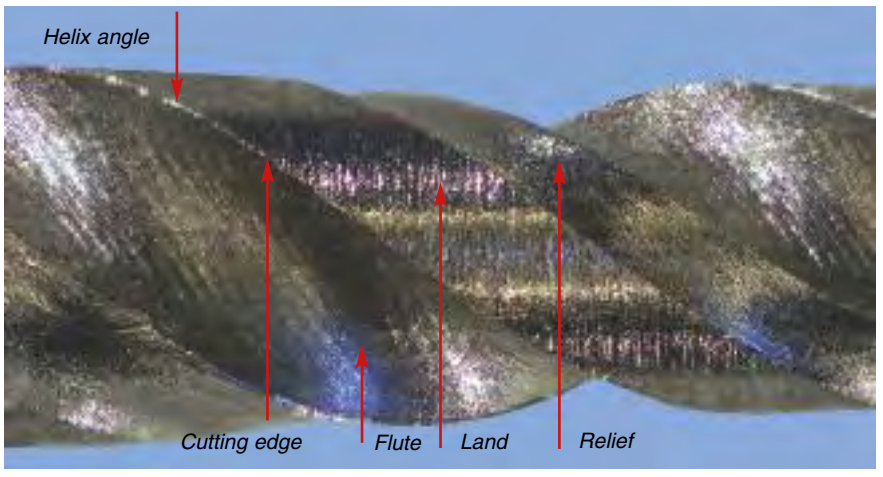


Fig. 2: Quantec file.

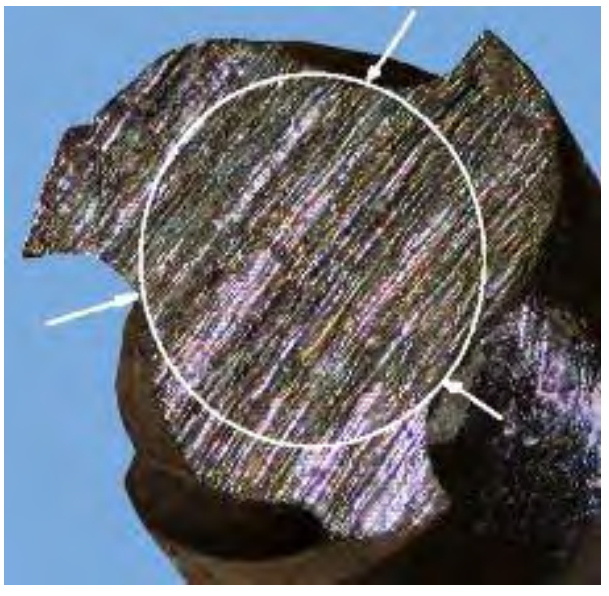
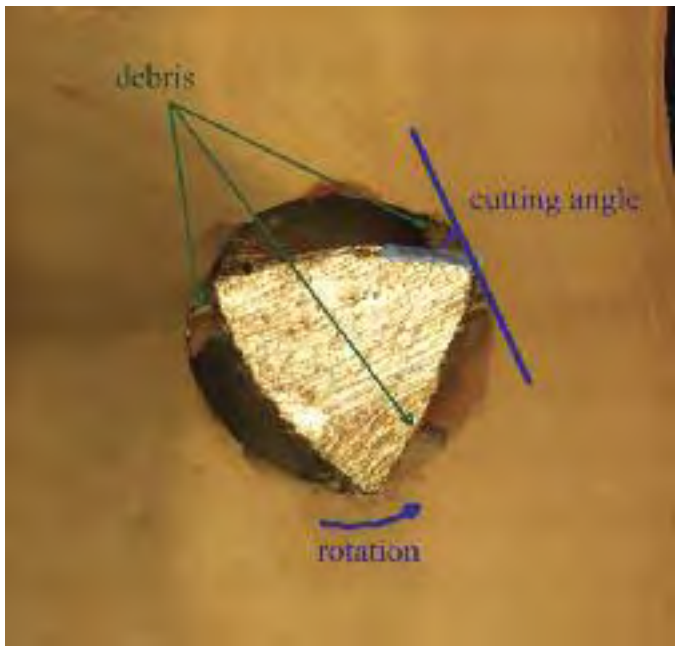


Fig. 3: The central core circumference shown in cross-section of the K-3 file is determined by the boundaries of the depths of the flutes or is described as the largest diameter of the cross-section that has not been ground. The core taper may be less than the file taper in order to proportionately increase the file's flexibility toward the handle. A 0.04 tapered file can have a 0.02 tapered core, and the file would have proportionally less cross-sectional mass toward the handle and greater flexibility toward the handle than if the core taper and file taper were the same.

Fig. 4a: The ProTaper file utilizes a negative angle of incidence to enlarge the canal. The surface of the file blade meets the canal wall with an acute angle resulting in a scraping action. More pressure is required when enlarging the canal in this manner.



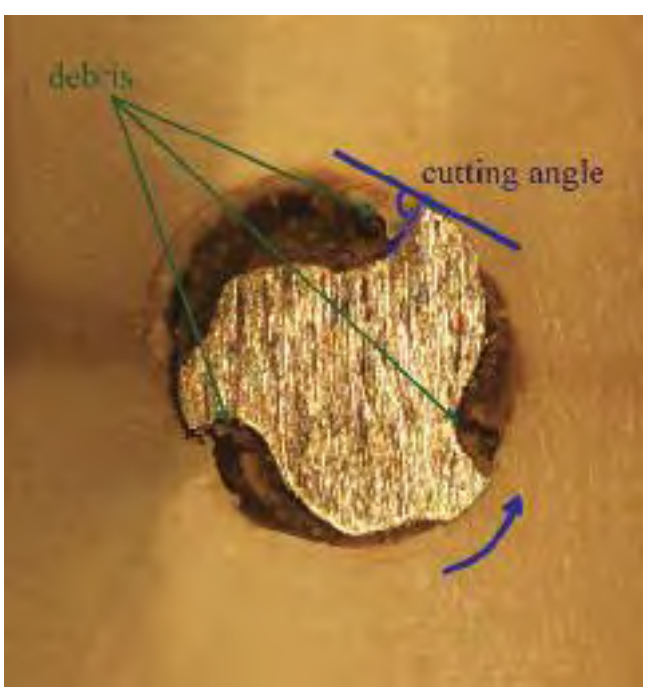


Fig. 4b: The K-3 file utilizes a slightly positive angle of incidence to enlarge the canal. The file blade meets the canal wall with an obtuse angle resulting in a cutting action. Less pressure is usually required when enlarging the canal in this manner. Excessive pressure can cause excessive torsion by forming chips too large to be dislodged.

extend as far axially from the center as the cutting edges that define the file's circumference. Lands are used to reduce screwing-in forces, support the cutting edge, reduce transportation, and limit the depth of cut in much the same manner that a safety razor functions. The surface of a land reduces the tendency of faults caused by stress or manufacturing imperfections in the metal to propagate along its cutting edge or circumference. Lands need not be very wide to function.

The force of abrasion is a direct result of the surface area of a land that rotates against the wall of the canal. Wide lands can result in excessive abrasion forces that increase the torque requirements for rotation.

In addition, faster rotations of a file cause the lands to further limit the depth of cut, and wide lands on larger files can prevent the blades from engaging an adequate depth into the canal.

Wide lands can be very useful in small diameter files by adding rigidity and by enabling the file to negotiate curvatures when canal enlargement is minimal.

When lands are too wide for effective canal enlargement, the files can be used very effectively for removing gutta-percha from the canal and for circulating irrigation in the canal.

File efficiency

Efficiency is defined as the ratio of the work done to the work equivalent of the energy supplied to it. An efficient file, a file having greater cutting ability, requires less time, torque and/or pressure to accomplish canal preparation.

The less pressure, torque and time required, the more likely file failure can be prevented. The concept is often confused, however, by describing a more efficient file as a more aggressive file, a term that seems to be used with a negative connotation.

Aggressive forces of the operator on an efficient file are unnecessary and can be counter-productive. For example, if one pushes with excessive pressure on an efficient file, the chips that are formed on the wall of the canal can be larger than can be removed without requiring significantly more torque than would have been required for forming and removing smaller chips with less pressure.

Clinicians who change file systems and begin working with more efficient files often have a tendency to apply the same time or force as was required with less efficient files. The excessive (aggressive) force on the more efficient file should be avoided, and the clinician will enhance the quality of preparation and reduce the threat of failure by learning to match the file's efficiency with the level of force required.

Without the benefit of efficiency data, clinicians often choose less efficient files because of the tactile sensations perceived. A file that enlarges a canal with inefficient scraping actions, for instance, can "feel" smoother than a file that uses cutting actions. How an instrument feels during use is not a reliable indication of its efficiency.

The major concern for an efficient instrument is its ability to transport the canal. It should be remembered that time as well as force are functions of efficiency, and less time will be required to transport as well as to enlarge a canal with an efficient file.

On the other hand, the less efficient file requires more time that results in more rotations and greater fatigue, and/or more force that results in greater torsion. The additional fatigue and torsion, of course, increase the possibilities of breakage.

One should also keep in mind that a file cannot transport unless it was at first where it should be, and only the excessive time it remains in that position results in transportation. Once a file has rotated one time in one position, the canal will be enlarged to the file's diameter, and to avoid transportation the file should not remain in that position once the canal is enlarged. Even very minor differences in file design dimensions can affect the cutting efficiency of files and their propensity for transporting canals.

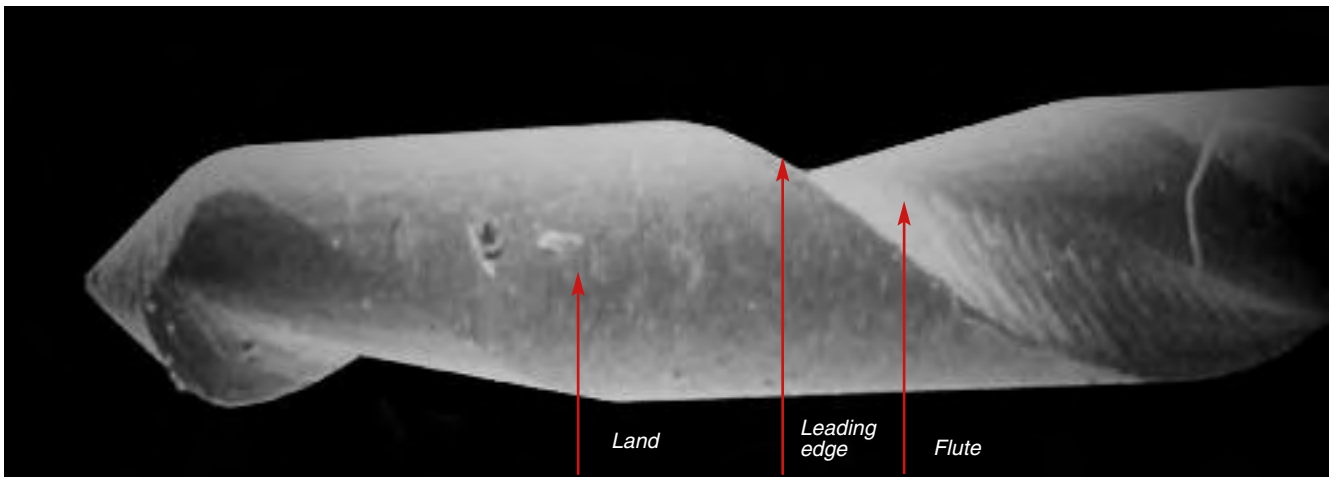


Fig. 5: The GPX instrument, Brasseler USA, is used for removing gutta-percha from the canal. The friction of the wide land rotating against gutta-percha causes it to plasticize while the spirals auger it from the canal. The instrument is very effective for removing gutta-percha but is ineffective as a larger size file because the land occupies most of the working surface and keeps the leading edge from engaging into the canal surface.

About the book

This article is an excerpt from Dr. John T. McSpadden's book, "Mastering Endodontic Instrumentation," published by Cloudland Institute.

The book is meant to help practitioners enhance treatment success, safely maximize efficiency, simplify complicated cases, understand effective instrumentation and develop expertise for evaluating instruments and techniques. It is illustrated with state-of-the-art photography and includes a history of instrument design evolution, hundreds of scientific evaluations and information on future developments. Book orders can be sent to the author directly by e-mail, at jtmc@me.com, or by mail to John T. McSpadden, 1403 Patten Road, Lookout Mountain, Ga. 30750, or by calling (706) 820-4287. Payment is by check for $149.95.

Future issues of Endo Tribune will contain more excerpts.

Design considerations

What are the most important relationships of the components of file designs and canal anatomies that enable us to improve our technique?

Careful examination of technique and design considerations identifies the limitations and usefulness of existing instruments and facilitates the development of a new generation of rotary instruments and techniques, one unencumbered by traditional concepts.

A few all-important consequential relationships of different file designs and tooth anatomies are useful in understanding how files function. Although research on endodontic instruments cannot determine with absolute certainty how files will react under all circumstances, research can result in inferences having significant predictability that can be used as considerations for instrument and technique design.

The following are some of the considerations and ramifications of designs that are most important in formulating techniques in approaching difficult cases:

1) A file with a more efficient cutting design requires less torque, pressure or time to accomplish root canal enlargement.

2) In a straight canal, the ability of a file to withstand torsion is related to the square of its diameter.

3) In a curved canal, the ability of a file to resist fatigue has an inverse relationship with the square of its diameter.

4) The torque required to rotate a file varies directly with the surface area of the file's engagement in the canal.

5) Fatigue of a file increases with the number of rotations of the file in a curvature.

6) Fatigue of a file increases with the degree of curvature of the canal.

7) To improve efficiency, the smaller the surface area of a file engaged in the canal, the greater the rotation speed should be.

8) The more spirals a flute has per unit length around the shaft of a ground file, the less resistance to torsion deformation there is, but the more flexible the file is.

9) The fewer spirals a flute has per unit length around the shaft of a ground file, the more it resists torsion deformation, but the more rigid it is.

10) The sharper the cutting blade of a file, the fewer spirals per unit length the file should have.

11) The greater the number of flutes with similar helix angles, the greater tendency a file has to screw into the canal and become bound.

12) Maximum engagement of a file occurs when it progresses into the canal at a rate that is equal to its feed rate, the rate the file progresses into the canal without the application of positive or negative pressure.

13) Less canal transportation occurs with a file having greater flexibility, an asymmetrical cross-section design, and/or a land.

About the author

John T. McSpadden is an international author, researcher and lecturer, inventor of numerous endodontic instruments, honorary member of the Societe Francaise d'Endodontie and the recipient of its Louis I. Grossman Award and a member of the American Association of Endodontists. He is author of "Mastering Endodontic Instrumentation," published by Cloudland Institute. He can be reached at jtmc@me.com.

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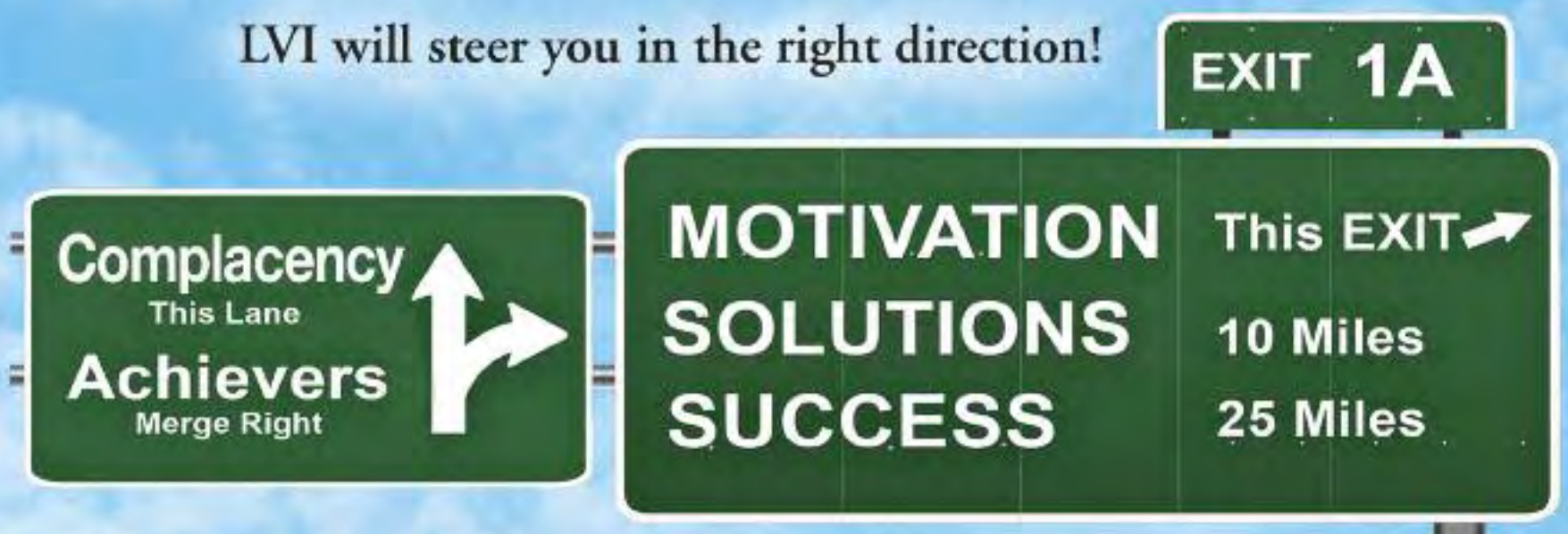

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