



NEW DIRECTIONS IN ENDODONTICS

Exclusive Interview with Clifford J. Ruddle, DDS

The field of endodontics is undergoing a continual evolution in terms of materials and techniques, as well as growth in the number of patients who can benefit from endodontic treatment. In order to gain insight into the current and future status of this important clinical area, *Dentistry Today* interviewed Clifford J. Ruddle, DDS a well known leader in endodontic innovations, clinical technique, and education. In this interview, Dr. Ruddle shares his views on aspects of endodontics that should be of particular interest to general practitioners.

DT: *How would you categorize the growth in endodontics and, in your opinion, what has driven this growth?*

Dr. Ruddle: There has been massive growth in endodontic treatment in recent years. By the early 1960's about 3 million teeth were endodontically treated in the United States annually. In the early 1990's, U.S. dentists were treating 40 million cases per year, and currently the profession is performing over 50 million endodontic procedures each year. This endodontic growth is extraordinary, and can be largely attributable to the ever-increasing acceptance of proven concepts, significant improvements in technology, and better-trained general dentists and specialists alike. Clearly, this unfolding story would not have been possible without the general public's growing selection of root canal treatment as an alternative to extraction. Over time, patients have become more comfortable voting for endodontics due to the change in perception that pain can be managed, one-visit endodontics is generally possible, and treatment is more predictably successful.

DT: *Has this rapid endodontic growth created unforeseen problems and, if so, what are the challenges we need to meet?*

Dr. Ruddle: The incredibly rapid growth in endodontics can be described as the good news / bad news dilemma. The good news is: hundreds of millions of teeth are salvaged through combinations of endodontics, periodontics, and restorative dentistry. The bad news is: if we treat 50 million cases per year and if the failure rate is just 10%, then there would be 5 million treatment failures per year. Extrapolating over the past three to four decades reveals that the number of failing endodontically treated teeth is massive, and could approach tens of millions!

Clearly, many previously treated endodontic cases currently need retreatment, many more teeth have already been non-surgically retreated, others have been surgerized, and a large number of failures have been extracted. Failures are neither good nor bad ...they just are. Mao Tse Tung wrote that the foundation of success is failure, with the important caveat, IF we accurately discern the cause of failure. The challenge is for dentists to fully embrace proven concepts, become more proficient, and take advantage of the significant procedural refinements which have occurred during the last decade so we can fulfill the public's higher expectations for predictable results. When the best of what endodontics has to offer is intelligently integrated, then the naturally retained root will be recognized as the ultimate dental implant (*Figure 1*).



Figure 1a. A pre-operative film shows multidisciplinary treatment. The maxillary left first molar's remaining palatal root is endodontically failing.



Figure 1b. Three-dimensional endodontic retreatment is the foundation of perio-prosthetics.

DT: *What are some of the controversies that potentially sabotage endodontic success, and how can these issues be resolved?*

Dr. Ruddle: When one evaluates the current status of clinical endodontics as a healing profession, one is struck by the vast differences in how endodontics is understood and practiced from country to country, state to state, city to city, office to office, and even practitioner to practitioner within each office. Yet, rational treatment approaches are available, precise treatment techniques have been perfected, and success rates approaching 100% are measurable. The differences in how endodontics is practiced relates to different belief systems, which have led to legendary controversies. To make my point, if one reviews the dental literature, you will find that there is virtually no agreement on a variety of fundamental issues. Let me give you a few examples.

There is no universal agreement as to what are the best techniques and methods for performing vital pulp testing. There is ongoing controversy regarding the size of an access cavity and the strength, temperature, and type of irrigant, as well as its potential to clean. Ongoing debate continues regarding working length and patency files, the sequence of canal preparation, and the ideal percentage taper that ensures a root canal system can be three-dimensionally cleaned and obturated. There is no agreement on sealers or what is the best, most effective technique to pack a root canal system. There is still plenty of controversy among clinicians as to whether a failing case should be retreated nonsurgically, surgerized, or extracted. With opinions so divergent on core issues, imagine the heightened confusion that exists for dentists trying to identify, assimilate, and integrate the best and most relevant new technologies and instruments.

All of these controversies make for exciting and turbulent times in clinical endodontics. Conclusions made in the dental literature must be balanced by clinical experience and longterm follow-up. A random review of countless endodontically treated cases begins to reveal the edges of the truth about those factors that influence success. Successful cases leave clues that can potentially guide our clinical actions. On the contrary, the avalanche of endodontic failures provides irrefutable evidence that our unresolved controversies perpetuate clinical breakdowns and decrease success rates. In the final analysis, science and basic research can illuminate our clinical endeavors, but ultimately it is by our clinical actions that our success as a healing profession is measured.

DT: *For so many years the endodontic armamentarium remained much the same, then suddenly, made enormous change. Can you identify the greatest innovations that have recently occurred in the field of endodontics?*

Dr. Ruddle: In my opinion, the greatest innovations in endodontics occurred, more or less, in the decade of the 1990's. The most important innovations have been the utilization of the dental operating microscope, ultrasonic technology and related instruments, nickel-titanium (NiTi) rotary shaping files, and mineral trioxide aggregate (MTA). Each of

these innovations has dramatically impacted endodontics and significantly contributed to more predictable success.

DT: *Let's look at the microscope first ... Could you tell us how you got interested in microscopes, how the use of microscopes has evolved in dentistry, and explain the clinical advantages of using a microscope?*

Dr. Ruddle: One of the true leaders in the field of endodontics is Dr. Noah Chivian, an endodontist from New Jersey. At the American Association of Endodontists (AAE) 1988 annual meeting, Noah, who already was a microscope user, had a booth on the exhibit floor and was demonstrating the advantages of enhanced magnification and light utilizing a microscope. Since I had already been using a headlamp and magnification glasses since grad school, this seemed like the next logical step. At this meeting, I purchased my first microscope, and within a few weeks was using it, albeit rather awkwardly, on patients of record. Over the next two years, as my skills steadily improved I tried several different kinds of microscopes, always looking for the scope that could provide the best optics, had features that would improve my documentation capabilities, and was endo friendly.

During this period, I met an endodontist named Dr. Gary Carr from San Diego, California. We began to work together to explore how we could better use this technology clinically. We spent countless hours sharing information on how we could refine existing procedures. As we were both using the microscope in our clinical practices, the next step was to integrate this technology into our respective teaching programs. In fact, the first endodontic microsurgical course given internationally was conducted in my teaching center January 25-26, 1991, to a group of 10 endodontists. What made this particular course significant was the introduction of the microscope and Gary's new method for performing root-end preparations utilizing ultrasonics. Ultrasonic root-end preparation in conjunction with the microscope went on to revolutionize the field of surgical endodontics.

By August 1995, since quite a few endodontists had already incorporated the microscope into practice and many more were beginning to use the microscope, the American Association of Endodontists (AAE) wanted to look at this technology in terms of whether microscope-assisted procedures should be taught in graduate programs. To answer this question, the AAE invited all of the post-graduate endodontic chairs from North America to Chicago for a 3-day symposium on the use of the microscope in clinical endodontics. The AAE called the course "Teach the Teachers" and invited Drs. Syngcuk Kim, John West, Gary Carr and myself to be the teachers. At the end of this symposium, the AAE chairs voted unanimously that all post-graduate endodontic programs would integrate the microscope into their teaching programs, such that every graduating endodontist would become proficient in the clinical use of the microscope by 1998.

With regard to the clinical advantages of using a microscope, there are many. There is an old expression, "If you can see it, you can probably do it." The microscope has

allowed us to finally visualize things previously unseen, and has driven the development of new armamentarium which has significantly refined endodontic procedural techniques. Beyond improved vision, other advantages are better posture and ergonomics, less stress and fatigue, enhanced ability to document, more effective case presentation and teaching, better diagnostics, greater staff pride and retention, and for the doctor, new found enthusiasm, satisfaction, and practice growth (*Figure 2*).

DT: *The second endodontic innovation you identified was ultrasonics. Can you describe when ultrasonics started, how it evolved, and its role in clinical endodontics?*

Dr. Ruddle: Ultrasonic technology has been in dentistry for many decades. However, its role in clinical endodontics was limited because traditionally most ultrasonic units were magnetorestrictive and provided inadequate power, and the ultrasonic instruments were too large to work safely within the root canal space. Then came piezoelectric ultrasonic energy which provided the needed range of power, and in combination with new instrument designs, significantly elevated clinical possibility. Clinicians are discovering that the utilization of ultrasonic technology improves vision, as there is no bulky handpiece head to obstruct vision and procedural access, and precision has greatly improved due to better instrumentation.

The evolution of ultrasonic technology occurred with the advent of the microscope. As an example, ultrasonic instruments had long been available but were not optimally designed. This problem created possibility for a solution. I began working with a high quality machine shop, and in 1996, we invented three unique ultrasonic features which were patented, and significantly improved clinical outcomes. First, we made all the nonsurgical line of ultrasonic instruments contra-angled to improve procedural access into the roots of all teeth. Second, we made the distal working portion of the instruments with parallel-sided walls to improve access and vision. Third, our instruments were made abrasive to improve sanding and cutting efficiency. These three manufacturing features had never been utilized on any nonsurgical ultrasonic instrument distributed in the world. Dentsply Tulsa Dental distributes these ultrasonic instru-



Figure 2. All phases of endodontic treatment are significantly improved when the dental team utilizes the microscope.

ments under the ProUltra trademark. Over time, microscopes in conjunction with ultrasonics have driven many microsonic techniques in the field of nonsurgical retreatment (*Figure 3*).

DT: *What are the various clinical applications where ultrasonic technology improves endodontic procedural success?*

Dr. Ruddle: A partial list of ultrasonic endodontic procedures today would include: Removing restorative segments following sectioning procedures, eliminating pulp stones, troughing for extra canals, chasing calcified canals, exposing previously missed canals, and activating intracanal irrigants. In the field of nonsurgical retreatment, ultrasonic applications include: eliminating core materials from the pulp chamber, retrieving posts and broken instruments, and removing obturation materials like gutta percha, silver points, carrier-based obturators, and brickhard resin pastes. Additionally, ultrasonics is used to vibrate MTA, and serves to adapt this material so we can seal canals which are immature or blunderbuss, or have been zipped, transported, or perforated due to iatrogenic or pathologic events.

DT: *The third major innovation you have identified that has significantly improved clinical endodontics is NiTi rotary files. Can you describe when NiTi was introduced and how it has evolved?*

Dr. Ruddle: The first NiTi rotary instrument came to market in about 1992. Dr. John McSpadden's company distributed this 0.02 tapered file utilizing Dr. Ben Johnson's idea of creating a rotary file with three radial lands and a taper similar to the carriers used with the Thermafil obturators. Although these instruments began to change how we looked at preparing canals, there were problems associated with breakage. In 1994, Ben introduced a more durable line of files which became known as the ProFile 0.04 tapered series. Soon followed the ProFile 0.06 tapers and the Orifice Shapers. These instruments all contained three radial lands and fixed tapers, and the files cut in a gentle planing, or scraping, action. Ben broke the paradigm of ISO 0.02 tapered files by making these greater tapered files, and is generally regarded as the father of NiTi rotary files. Other rotary file

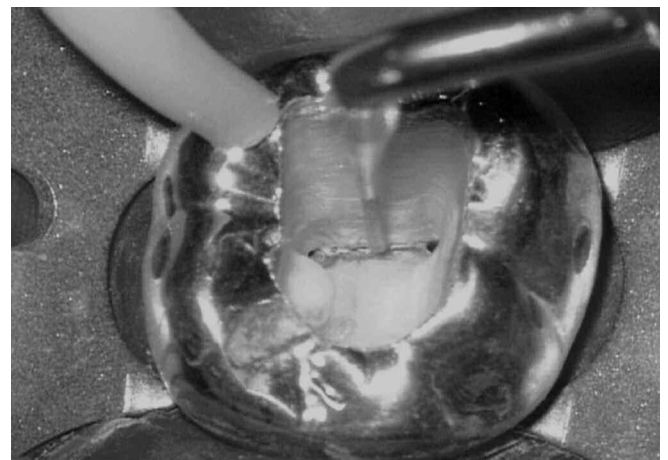


Figure 3. A photograph demonstrates an ultrasonic ProUltra Endo Tip precisely troughing along the groove between the MB and ML orifices.

lines came along, each with its purported advantages, such as Lightspeed developed by Dr. Steve Senia, Quantec by Dr. John McSpadden, and GT files by Dr. Steve Buchanan.

DT: *Can you describe the advantages of using NiTi rotary files?*

Dr. Ruddle: There are many advantages for utilizing NiTi rotary instruments for shaping root canals. Traditionally, canal preparations have been performed using a series of stainless steel files, oftentimes in conjunction with gates glidden drills or peeso reamers. During use, the potential for blocks, ledges, external transportations, and/or strip or apical perforations is always present. Advantageously, NiTi rotary shaping files have nearly eliminated these iatrogenic events. Other important advantages of shaping canals with NiTi files are improved efficiency, the opportunity to schedule more “one visit” endodontic procedures, and improved profitability. Additional advantages of using NiTi files are fewer post-operative flare-ups, the ability to open canals more easily and with less effort, and the creation of more consistent and uniform canal shapes. All these advantages create a win-win for the doctor and patient alike.

DT: *With all the advantages using NiTi rotary instruments, why are many clinicians reticent to embrace this important technology?*

Dr. Ruddle: The reasons for not utilizing NiTi rotary instruments vary, but the greatest concern I hear is the fear of

instrument breakage. On further questioning, I usually find that most of the broken instrument upsets were caused by failure to follow the directions for use for specific instrument lines, failure to adhere to the specific international protocols for rotary files, and failure to practice this technology first on extracted teeth.

Another concern that clinicians express is that dentistry is advancing so rapidly on so many fronts that it is a challenging task just to “keep up”, let alone try to investigate, learn, and incorporate the newer technologies, instruments, and techniques. Although it is not always wise to be the first to adopt a new technology, it is also not desirable to be the last. Strategically, clinicians often ask “when” should I change. From a practical standpoint, the longer a clinician waits to embrace a proven technology, the harder it is to change. If we wait too long, the gap becomes wider and harder to bridge. Change usually is made most effectively in small, controlled increments. This step-by-step approach to learning helps each clinician move towards their potential, and serves as the blueprint to building greater practice success.

Finally, some clinicians express concerns about embracing NiTi rotary technology because of cost. It is true that there is a monetary investment associated with purchasing a new torque control electric motor, purchasing the instruments, and the costs associated with training. However, these costs are completely offset by the numerous advantages I previously mentioned. The reduction in chair time alone is a compelling argument for the use of NiTi files. When clinicians express strong concerns related to costs, I recommend they add \$40-\$50 to their fee to offset this cost, and then more confidently start each case with a brand new set of files.

DT: *What about all the new NiTi file lines that have recently come to market? Could you explain why there is a need for more rotary instruments?*

Dr. Ruddle: There are several new lines of files that have recently become available, all of which are quite different in design and performance. Over several years, as we have used NiTi files, taught rotary preparations, and invited clinical feedback, we have learned that dentists are looking for four features. The features are improved efficiency, better flexibility, greater safety, and importantly, simplicity. Surveys from the international opinion leaders have rated the ProTaper files as coming closest to fulfilling these desirable and sought after features. Synergistically, more creative and sophisticated instrument designs, in conjunction with advanced machining techniques, have taken NiTi rotary files to the next level and have dramatically benefited clinical performance (*Figure 4*). Even with all the current improvements in file design and machining, the profession will continue to develop new, more innovative instruments as we pursue the endless journey towards a more perfect file.



Figure 4. A graphic animation demonstrates the remarkable flexibility of a NiTi ProTaper rotary shaping file.

DT: *Earlier, you identified the four greatest endodontic achievements of the 1990's. We have discussed microscopes, ultrasonics, and NiTi rotary instruments. Could you discuss Mineral Trioxide Aggregate and describe its applications and clinical benefits?*

Dr. Ruddle: Mineral Trioxide Aggregate (MTA), commercially available as ProRoot, was developed by Dr. Mahmoud Torabinejad, who is department chairman of post-graduate endodontics at Loma Linda University. ProRoot is a material that creates an extraordinary breakthrough for pulp capping, packing certain canals, and managing radicular repairs. ProRoot can be used in canals which exhibit reverse apical architecture, such as immature roots or iatrogenic transpositions. Importantly, ProRoot is the material of choice when repairing perforations both nonsurgically and surgically, and is commonly utilized in retrograde preparations to seal canals. Remarkably, cementum grows over this nonresorbable and radiopaque material, thus allowing for a normal periodontal attachment apparatus. Although a dry field facilitates visual control, ProRoot is generally not compromised by slight moisture, and typically sets brick-hard within 4-6 hours, creating a seal as good as or better than the best materials used today (*Figure 5*).

DT: *Would you be willing to predict some of the future developments we will see in clinical endodontics?*

Dr. Ruddle: Endodontic diagnosis and treatment will significantly improve in the years immediately ahead due to a greater understanding, appreciation, and codification of the fundamental knowledge. Central to the continued growth and success of clinical endodontics will be technologically-driven advancements. Pulpal diagnostic schemes will emphasize full mouth testing and measure each pulp's vascularity. Clinicians who want to maximize success will routinely use the operating microscope. Handpiece heads will become smaller, affording better vision. Access burs will be

refined, developed, and simplified to help us more consistently and safely meet this objective. Ultrasonic technology will continue to grow and play an ever increasing role in all aspects of endodontic treatment.

The role of hand instruments will continue to diminish, but importantly, better metals and designs will allow clinicians to more readily explore and negotiate canals. NiTi rotary instruments will continue to evolve, simplify, and afford greater safety. Some of the NiTi improvements will be related to innovations in electric motors, which will include feedback features that will optimize file performance. Sensors will scan files, analyze stresses, and prognosticate breakage. Intracanal irrigants will improve, appear radiopaque on working films, and the future endogram will phenomenally impact diagnostics. Further, irrigating devices and canuli will provide more efficiency and desirable options while promoting safety. Fully-tapered microbrushes will clean canals and more optimally finish preparations. Sealers will improve, become more dimensionally inert, biocompatible, osteogenic, and readily facilitate the efforts of the restorative dentist. Although there has been much interest in replacing gutta percha, it will continue to be the obturation material of choice for the next several years because it readily fulfills the many traits deemed critical and essential. Importantly, gutta percha delivery methods will improve, simplify, and increase the potential for 3-D obturation.

Despite all the promises in the future for greater clinical satisfaction, clinicians must still work on the fundamentals that provide success. The one thing that has never changed in the history of mankind is root canal systems and their infinite range of anatomical variability. The one thing to remember is that proven concepts tend to endure whereas instruments and techniques come and go. There is an old expression for wise clinicians to consider: "Give a man a fish and he will eat for a day...Teach a man to fish and he will eat for a lifetime". ▲



Figure 5. *A photograph demonstrates an ultrasonic ProUltra Endo Tip vibrating MTA into the MB canal and related perforation.*