CE article
Er:YAG & Nd:YAG dual wavelength laser

technique
Matching gutta-percha cones to NiTi rotary instrument preparations

opinion
Relieved reamers and the 30-degree reciprocating handpiece
ROOTS SUMMIT
NOV. 30 - DEC. 3, 2016
THE MASTERS OF ENDODONTICS

ARE MEETING IN DUBAI WITH THE ROOTS COMMUNITY
DATE: NOV. 30 - DEC. 3, 2016
LOCATION: CROWNE PLAZA, DUBAI
Dear Reader,

Endodontics is one of the dental specialties in which the most significant technological innovations have been introduced. As Prof. Gorni recently pointed out: “The major innovations have encompassed instruments, materials and equipment. In terms of the improvement in instruments, rotary nickel-titanium (NiTi) files are the greatest innovation. Regarding materials, bioceramic cements have to be taken into consideration, since they represent an enormous opportunity for the clinician.” To the list of innovations I would also add lasers and its applications in endodontics.

I have pleasure in inviting you to read this year’s second issue of the roots magazine, in which you can find many helpful articles, including a report on the use of dual wavelength lasers by Drs. Lawrence Kotlow, Enrico DiVito and Giovanni Olivi. As their article points out, these lasers have uses in many different clinical situations. Perhaps most impressive is the use of this equipment in root canal therapy.

Also in this issue of roots magazine, you will learn about root canal disinfection, canal preparation and filling, as well as the newest products and events.

Please note that most of the issues of roots magazine also contains a CE component. By reading the article on dual wavelength lasers mentioned above, and then taking a short online quiz about this topic at www.DTStudyClub.com, you will gain one ADA CERP-certified CE credit.

To learn more about how you can take advantage of this CE opportunity, visit www.DTStudyClub.com. You only need to register at the Dental Tribune Study Club website to access these CE materials free of charge. You may take the CE quiz after registering on the DT Study Club website.

Yours faithfully,

Magda Wojtkiewicz
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MOVEMENT BY SWEDEN

The S1 System – reciprocating, smooth and flexible. Like a dance.
Seven dental marketing mistakes ...and how to avoid them

Author: Carolyn S. Dean, Australia

As a dental professional, you face unfamiliar challenges in running and marketing your practice. You are confronted with increased competition (both locally and abroad), an oversupply of dentists, ever-rising practice operating costs, and more marketing-savvy patients. On top of this, your potential patients are becoming more discerning about where they go for dental treatment, with many heading overseas.

In order to achieve practice success, it is essential to build long-term relationships with patients and prospects. Long-term patients are more likely to feel satisfied. It is they who welcome the opportunity to refer others to you and who will continue to use your services in the future.

Over my years working with hundreds of dentists as a marketing consultant, I have observed the common mistakes that prevent them being able to market their practices successfully.

1. Not knowing your numbers and not tracking them

One of the most common mistakes that I see is that many dental practices just do not track their numbers. There is a saying that "if you fail to plan, you plan to fail". It is critical that you track all of the metrics in your business, and your marketing spend is no exception. The significant numbers that you need to know and track are:

- average lifetime value of a patient,
- marketing return on investment,
- new patients,
- patient loss.

2. Not knowing your ideal patient

One of the cornerstones of any marketing campaign is knowing who your ideal patient is. Many practices make the mistake of not identifying this in their eagerness to go ahead with their marketing campaign as soon as possible. You need to stop and think about whom your marketing will be directed to, what this group of patients wants, what problems they have, and what solutions they need. The key to implementing a strategic marketing plan is identifying your practice's ideal patient or target patient profile.

Once you know your market, you need to establish how best to communicate with them.

3. Wanting a silver bullet

Marketing your dental practice to attract the right kind of patients, keep them active, and encourage them to refer you to their contacts is no easy task. Many practices think
Many practices think (and hope) that there is a silver bullet to solve their marketing issues. This leaves them open to unscrupulous sales people and to disillusionment and frustration when their marketing efforts fail. The companies trying to sell you the marketing silver bullet that will solve all your marketing worries are constantly calling. Your well-meaning friends, colleagues and patients may give you advice on what they think you should do to market your practice. The range of marketing media is evolving, and the rapid changes in online marketing make it almost impossible to keep up.

4. Taking a scatter-gun approach

I speak to many dentists who tell me that they have tried many different types of marketing and they have all failed and nothing has worked for them. When I dig deeper, I discover that they have tried many different approaches, but nearly all of these have been done in a haphazard way and in short bursts. I call this a "scatter-gun approach" to marketing. It does not work to try one approach for a month or two in an inconsistent manner without tracking the results or refining the campaign. This will always end in failure. It has been shown that it can take between six and eleven repetitions for patients to see or hear a message before they act on it. Do you know how many ways and how many times you communicate with your patients?

5. Doing it all by yourself

You have to remember that patients are more savvy than ever before. They are constantly exposed to a huge amount of marketing and their expectations of what is and is not professional are continually increasing. The reality is that when you are competing against the corporates, you need to ensure that your marketing is up to scratch.

It is very common for practices to have their branding and logo professionally designed and then decide to take it over, producing home-made brochures and other marketing collateral that use different colours, fonts and even versions of the logo. If you are not consistent, your attempts at establishing a brand will be ineffective.
6. Procrastinating

There are just so many things for you to think about when it comes to your dental marketing. How can you fix your website that is not effective? Should you be engaging with your patients on social media and how to start? You know that you need to educate your patients on a regular basis, but what are the best ways to do this? You need reactivation and referral campaigns, but you have no idea how to carry this out in a professional and consistent manner. It is not uncommon to be so confused and overwhelmed that you spend your time procrastinating and doing nothing.

7. Not getting the right advice

When you own or run a dental practice, in fact any kind of business, there is no shortage of marketing advice to follow; there is an overwhelming amount of advice out there. You may have had the experience of wasting time or money on poor advice. The problem is that many dentists are not getting the right dental marketing advice. They may listen to many different sources and form opinions based on advice from people who may not understand the business of dentistry.

8. Summary

There is no magic when it comes to marketing your practice successfully. Quite simply, it comes down to:
• picking the aspects of marketing you want to use, wisely and with due care and thought;
• ensuring that, whatever marketing activities you decide to undertake, you perform to the best of your ability and budget;
• being consistent;
• tracking your results—setting your goals and reviewing or refining them on a regular basis;
• getting good advice from trusted experts in the area of marketing you are undertaking.

It takes time, but the effort that you put in will be rewarded by more patients, increased production, better relationships with your team and patients, and a sense of control when it comes to your marketing. It is now time for you to focus on your marketing. By marketing well, doing it consistently, and avoiding the scatter-gun approach, you can avoid making the common mistakes that many practices make.

about

Carolyn S. Dean is a dental marketing and communications specialist and seminar speaker. As Managing Director of My Dental Marketing, she works with practitioners throughout New Zealand and Australia on enhancing websites, improving branding and growing dental practices. Her book Fully Booked: Dental Marketing Secrets for a Full Appointment Book was published in March. Recently, Carolyn presented three different lectures on the importance of marketing for dental practices as part of the ADX16 continuing professional development programme in Sydney in Australia.
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Er:YAG & Nd:YAG dual wavelength laser

From everyday dentistry to advanced photoacoustic endodontic applications (PIPS)

Authors: Drs Lawrence Kotlow, Enrico DiVito, USA, & Giovanni Olivi, Italy

Introduction

Lasers provide an exciting new technology that allows the dentist the ability to give patients optimal care without many of the “fear factors” found in conventional dental techniques. Used with proper understanding of laser physics, lasers are extremely safe and effective.

Using lasers for caries removal, perio treatment, endodontic treatment, bone management, cutting and shaping, and soft tissue procedures can reduce postoperative discomfort, infection and provide safe, simple in-office treatment. As a result, we can improve our efficiency, expand what we can do, achieve better results and increase production.

Lasers represent a real quantum leap forward in the treatment of our patients, including the paediatric patient. The US Food and Drug Administration (FDA) gave approval for the use of the Er:YAG laser in 1997 for both hard- and soft-tissue procedures. The erbium doped (erbium particles placed within the YAG crystal) crystal of Yttrium-Aluminum-Garnet’s (Er:YAG) development and success has made the treatment of children safer and quicker.

Plainly stated, a laser is a piece of equipment that creates a concentrated monochromatic beam of visible or infrared light that can be absorbed by a specific target. Since then, laser-assisted dental care has changed forever the way dentists can prepare diseased teeth, ablate bone and treat soft tissue abnormalities and disease. An entire new standard of care is becoming a reality.

Lasers and paediatric dentistry are a perfect fit. There are a wide range of hard and soft dental procedures that may be completed using lasers as an alternative to conventional dental care on adults and, especially, children. Many of these procedures may be treatments dentists historically refer out to other specialists; however, if you understand and use your laser efficiently, you will discover that many of these are procedures that every dentist can easily complete.

The question that is often the major concern and barrier to investing in lasers is the how this investment will pay for itself, more recently described as return on your investment (ROI). Will it pay for itself? We prefer to speak of this as the secondary effect. If you understand your laser, it will easily pay premiums on your investment, and the cost factor becomes a non-issue.

The purchasing of lasers is an investment, not an expense, for any dental practice.

Lasers represent a fundamental change in the entire way dentistry has been taught. We can now rethink and often modify G.V. Black’s principle of extension for prevention with the concept of minimally invasive micro-dentistry. We need to understand that laser dentistry is one portion of an entire new way of practicing conservative, pain-free dentistry.

The laser that we call the “all-purpose” laser is the Lightwalker Er:YAG & Nd:YAG laser, manufactured by Fotona and distributed in the United States by Technology4Medicine. The Er:YAG produces its effect at 2,940 nm and has as its primary tissue target water and hydroxyapatite. It is very safe, relatively quiet, eliminates the smells and vibrations associated with the dental handpiece and, most importantly, is much more comfortable for the patient, significantly reducing the need for local anaesthesia.
The use of the new generation erbium lasers for repair of incipient hard-tissue disease allows the dentist to provide a stress-free means of restoring teeth in a minimally invasive manor, most often with no shot and no numb lip, without the need for any local anaesthetics.

The erbium laser can be used for restoring primary and permanent teeth, eliminating or reducing the amount of local anaesthetics. In most cases, the patient will not require numbing for Class 1, 2 (sometimes), 3, 4, 5, 6 restorative procedures using bonded restorative materials. Using the concept of minimally invasive restorative procedures, the Er:YAG laser allows the operator to remove only diseased tissue and thus preserves much more of the healthy unaffected tooth.

In cases where alloy is preferred, the laser’s analgesia effect may also allow the dentist to create a restorative preparation using a conventional handpiece that is not meant for bonding. The erbium laser is effective because of its effect on its target, water within the tooth structure. This effect occurs when the laser heats up water within the target tissue, causing it to create small microscopic explosions (photothermal followed by photoacoustic effects). When applied to soft tissue, bone or teeth and cavities, the explosions then cause the areas to be vaporized.

Er:YAG laser 2,940 nm:
Soft-tissue procedures

There is a wide array of soft-tissue procedures that are able to be completed using the all-purpose laser: maxillary and mandibular frenum revisions, lingual frenum revisions, treatment of pericoronar pain or infection, removal of hyperplastic tissue because of drugs or poor oral care in orthodontic patients, biopsies, treatment of aphthous ulcers and herpes labialis, pulpotomies, removal of impacted teeth and in adults apicoectomies and bone recontouring.

Pulpotomies

Parents often express concern about the need to take radiographs because of the nature of X-rays and their possible side effects on their child’s overall health. They question the use of alloys because of the chemical make-up of the alloy. Whether these should be a real concern in today’s dental care is open to debate, depending on your individual beliefs. There are also concerns by many, although not as loudly, about the effect of various pulpotomy procedure medicaments used in pulpotomy procedures such as formocresol.

Lasers provide a safe, non-chemical effective alternative treatment for pulpotomies. During eight years, post-treatment results on more than 4,000 pulpotomies using the erbium (2,940 nm) laser provides ample evidence that this method is both effective and safe for children without the need for introducing chemicals or using electrosurgery methods.

When the final result of orthodontic positioning of the front teeth results in gingival hypertrophy, the laser can be a useful tool to increase crown length and give the patient a more aesthetic smile. This may often be accomplished without the need for local anaesthesia. Patients who have medically induced hyperplasic tissue, such as patients requiring dilantoin, can also have their tissue reduced and reshaped with the erbium.

In addition to the many examples described in this article, lasers can be used for additional procedures not usually required in paediatric dentistry, such as revisions of the abnormal mandibular frenum, often avoiding the need for soft-tissue grafts, crown-lengthening procedures where bone requires recontouring, apicoectomies, removal of boney exostoses, removal of third molar impactions, removal of root remnants, incising and draining soft-tissue infections, advanced periodontal treatments and the latest in advanced endodontic treatment via photoninduced photoacoustic streaming.
The goal of endodontic treatment is to obtain effective cleaning and decontamination of the smear layer, bacteria and their byproducts in the root canal system. Clinically, traditional endodontic techniques use mechanical instruments, as well as ultrasonic and chemical irrigation, in an attempt to shape, clean and completely decontaminate the endodontic system but still fall short of successfully removing all of the infective microorganisms and debris. This is because the complex root canal anatomy and the inability for common irrigants to penetrate into the lateral canals and the apical ramifications. It seems, therefore, appropriate to search for new materials, techniques and technologies that can improve the cleaning and the decontamination of these anatomical areas.

Among the new technologies, the laser has been studied in endodontics since the early 1970s and has become more widely used since the 90s. Different wavelengths have been shown to be effective in significantly reducing the bacteria in the infected canals, and important studies have confirmed these results in vitro. Studies reported that near infrared laser are highly efficient in disinfecting the root canal surfaces and the dentinal walls (up to 750 microns the diode 810 nm and up to 1 mm the Nd:YAG 1,064 nm). On the other hand, these wavelengths did not show effective results in debriding and cleansing the root canal surfaces and caused characteristic morphological alterations of the dentinal wall. The smear layer was only partially removed and the dentinal tubules primarily closed as a result of melting of the inorganic dentinal structures.

Other studies reported the ability of the medium infrared laser in debriding and cleaning root canal walls. The bacterial load reduction after erbium laser irradiation, demonstrated high on the dentin surfaces, but low in depth of penetration because of the high absorption of laser energy on the dentin surface. Also the laser activation of commonly used irrigants (LAI) resulted in statistically more effective removal of debris and smear layer in root canals compared with traditional techniques (CI) and ultrasound (PUI). Additionally the laser activation method resulted in a strong modulation in reaction rate of NaOCl significantly increasing production and consumption of available chlorine in comparison to ultrasound activation.

A recent study has reported how the use of an Er:YAG laser, equipped with a newly designed radial and stripped tip, in combination with 17 per cent EDTA solution, using very low pulse duration (50 microseconds) and low energy (20 mJ) resulted in effective debris and smear layer removal with minimal or no thermal damage to the organic dentinal structure through a photoacoustic technique called photon induced photoacoustic streaming or “PIPS.” Also the same photoacoustic protocol in combination with 5.25 per cent sodium hypochlorite solution has been investigated and shown to reduce the bacterial load and its associated biofilm in the root canal system three dimensionally.

Other similar studies are in progress for publication and the results are promising and suggest a three-dimensional positive effect of this laser-activated decontamination (LAD) method.

The purpose of this article is to present briefly the experimental background of this laser technique and to introduce the clinical protocol.

Scientific background

The microphotographic recording of the LAI studies suggested that the erbium lasers used in irrigant-filled root canals generate a streaming of fluids at high speed through a cavitation effect. The laser thermal effect generates the expansion-implosion of the water molecules of the irrigant solution, generating a secondary cavitation effect on the intra-canal fluids. To accomplish this streaming, it is suggested the fiber be placed in the middle third of the canal, 5 mm from the apex and stationary. This concept greatly simplifies the laser technique, without the need to reach the apex and to negotiate radicular curves.

Also, the recorded video of the new technique, PIPS, showed a strong agitation of the liquids inside.
the canals. It differs from the already cited LAI technique by activating the irrigant solutions in the endodontic system through a profound photoacoustic and photomechanical phenomena. The use of low energy (50 microsecond pulse, 20 mJ at 15 Hz, 0.3 W average power, or less) generates only a minimal thermal effect. The study with thermocouples applied to the radicular apical third revealed only 1.2 °C of thermal rise after 20 seconds and 1.5 °C after 40 seconds of continuous radiation.14

When the erbium laser energy is delivered at only 50 microsecond pulse duration through a special designed tapered and stripped 400 microns tip (Fotona LightWalker, Technology4Medicine), it produces a large peak power of 400 watts when compared to a longer pulse duration. Each impulse, absorbed by the water molecules, creates a strong “shock wave” that leads to the formation of an effective streaming of fluids inside the canal while also limiting the undesirable thermal effects seen with other methodologies. The placement of the tip in the coronal portion only of the treated tooth allows for a more minimally enlarged canal preparation with less thermal damage as seen with those techniques placed into the canal system.

The root canal surfaces irrigated with 17 per cent EDTA and laser activated for 20 seconds showed exposed collagen matrix, opened tubules and the absence of smear layer and debris (Figs. 1-3). The rinsing with 5.25 per cent sodium hypochlorite and laser irradiation for 20 seconds produced a strong activation of the solution, as reported by Macedo,13 improving the disinfecting action of the sodium hypochlorite.16 The disinfecting action of PIPS is very effective both on the root surface, the lateral canals and the dentinal tubules, as confirmed with SEM and confocal studies (Fig. 4).

The profound and distant effect of PIPS eliminates the need to introduce the tip into the root canal system. Unlike traditional laser techniques requiring placement of the tip 1 mm from the apex, or even 5 mm from the apex as proposed for LAI18, the PIPS tip is placed in the coronal portion of the pulpal chamber only and left stationary allowing the photoacoustic effect to spread into the openings of each canal. A new tip design consisting of a 400-micron diameter, 12 mm long, tapered end is used for this technique (Fig. 5). The final 3 mm of coating is stripped from the end to allow for greater lateral emission of energy compared to the frontal tip.

This mode of energy emission allows for improved lateral diffusion with low energy and enhanced photoacoustic effect.

Discussion

Laser irradiation is a common technique used in endodontics to improve both the cleaning, the debriding and disinfection of the root canal system. Many wavelengths and protocols are used. Near infrared lasers are used for the three-dimensional decontamination of the endodontic system. Nd:YAG and diode lasers use thermal energy to destroy bacteria. Observations reveal a certain grade of thermal injury to the root canal surface and create a typical morphological damage. Moreover, they are not able to thoroughly remove the smear layer.

On the contrary, erbium lasers are used for their effective smear layer removal while their bactericidal activity is limited to the root surface. The placing of the tip close to the apex and its back movement during the activation process is related to the risk of apical perforation, ledging and surface thermal damage, because of the ablation ability of this wavelength. Also a combination of the near and medium infrared lasers has been proposed. A technique, called twinlight endodontic treatment (TET), uses the erbium laser energy first, to clean the root canal surface and remove the smear layer, and the Neodimium:YAG laser second, used in dry mode as the final disinfecting step. All these techniques utilize traditional tips and fibres placed into the canal, close to the apex (1 mm) with all the corresponding thermal disadvantages observed in long, narrow and curve canals.

The erbium lasers are also used as a medium of activation of commonly used irrigants (LAI), avoiding the risk of thermal damage, while increasing the cleaning and disinfecting activity of the fluids. PIPS, in partic-
about

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Dr Enrico DiVito, DDS, is an Adjunct Professor at the Arizona School of Dentistry and Oral Health. He is in private practice at the Arizona Center for Laser Dentistry in Scottsdale, AZ, in conjunction with MDATG research group.

Dr Giovanni Olivi, MD, DDS, is a Professor of endodontics at the University of Genoa School of Dentistry, where he is director for the Laser in Dentistry Master Course with Prof. S. Benedicenti. He is in private practice in Rome, Italy.

Lasers are an extremely versatile addition to the dental practice and can be used in many instances instead of the conventional methods employed by the vast majority of dentists. Incorporating a laser in the dental practice should be viewed as an investment rather than a cost. When used with a good knowledge of laser physics, training and safety, lasers provide our patients a new standard of dental care...

References


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Christine Berthold (Canada)
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3-6 June 2016, Cape Town, South Africa www.ifea2016.com
New Technologies—
to improve root canal disinfection

Introduction
The major causative role of micro-organisms in the pathogenesis of pulp and periapical diseases has clearly been demonstrated. The main aim of endodontic therapy is to disinfect the entire root canal system, which requires the elimination of micro-organisms and microbial components and the prevention of its reinfection during and after treatment. This goal is pursued through chemomechanical debridement, for which mechanical systems are used with irrigating solutions.

Standard endodontic irrigation protocol
Sodium hypochlorite
Sodium hypochlorite (NaOCl) is the main endodontic irrigant used, owing to its antibacterial properties and its ability to dissolve organic tissue. NaOCl is used during the instrumentation phase to increase its time of action within the canal as much as possible without it being chemically altered by the presence of other substances. The effectiveness of this irrigant has been shown to depend on its concentration, temperature, pH solution and storage conditions. Heated solutions (45–60 °C) and higher concentrations (5–6 %) have greater tissue-dissolving properties. However, the greater the concentration, the more severe the potential reaction if some of the irrigant is inadvertently forced into the periapical tissue. In order to reduce this risk, the use of specially designed endodontic needles and an injection technique without pressure is recommended. EDTA has the ability to decompose the inorganic component of intracanal debris and is generally used in a percentage equal to 17 %. EDTA appears to reduce the antibacterial and solvent activity of NaOCl; thus, these two liquids should not be present in the canal at same time. For this reason, during mechanical preparation, abundant and frequent rinsing with NaOCl is performed, while the EDTA is used for 2 min at the end of the preparation phase to remove the inorganic debris and the smear layer from the canal walls completely.

Ultrasound activation of NaOCl
The use of ultrasound during and at the end of the root canal preparation phase is an indispensable step in improving endodontic disinfection. The range of frequencies used in the ultrasonic unit is between 25 and 40 kHz. The effectiveness of ultrasound in irrigation is determined by its ability to produce cavitation and acoustic streaming. Cavitation is minimized and limited to the tip of the instrument used, while the effect of acoustic streaming is more significant. Ultrasound creates bubbles of positive and negative pressure in the molecules of the liquid with which it comes into contact. The bubbles become unstable, collapse and cause an implosion similar to a vacuum decompression. Exploding and imploding they release impact energy that is responsible for the detergent effect. It has been demonstrated that ultrasonic activation of NaOCl dramatically enhances its effectiveness in cleaning the root canal space, as ultrasonic activation greatly increases the flow of liquid and improves both the solvent and antibacterial capacities and the removal effect of organic and inorganic debris from the root canal walls.
Ultrasonic activation of NaOCl of 30–60 s for each canal, with three cycles of 10–20 s (always using new irrigant), appears to be sufficient time to obtain clean canals at the end of the preparation phase (Figs. 1 & 2). Ultrasound appears to be less effective in enhancing the activity of EDTA, although it may contribute to better removal of the smear layer. The accumulation of debris produced by mechanical instrumentation in inaccessible areas is preventable by using ultrasonic activation of NaOCl even during the preparation phase. The use of a system of ultrasonic continuous irrigation might therefore be advantageous. It involves the use of a needle activated by ultrasound. With this method, the irrigant is released into the canal and is activated by the action of the ultrasonic needle simultaneously.

Chlorhexidine
A final flush with 2 % chlorhexidine (CHX) after the use of NaOCl (to dissolve the organic component) and EDTA (to eliminate the smear layer) has been proposed to ensure good results in cases of persistent infection, owing to its broad spectrum of action and its property of substantivity. However, the use of CHX is hindered by the interaction between NaOCl and CHX, which tends to create products that may discolor the tooth and precipitates that may be potentially mutagenic. For this reason, CHX should not be used in conjunction with or immediately after NaOCl. This interaction can be prevented or minimized by an intermediate wash with absolute alcohol, saline or distilled water.

Activation systems
Mechanical instrumentation alone can reduce the number of micro-organisms present within the root canal system even without the use of irrigants and intracanal dressings, but it is not able to ensure an effective and complete cleaning. Irrigating solutions without the aid of mechanical preparation are not able to reduce the intracanal bacterial infection significantly. For these reasons, today research is oriented toward the study of systems that can improve root canal disinfection through mechanical activation of endodontic irrigants, and in particular NaOCl. Multiple agitation techniques and systems for irrigants have been used over time, demonstrating more or less positive results.

Manual agitation techniques
The simplest technique of mechanical activation of irrigants is manual agitation, which can be performed with different systems. The easiest way to achieve this effect is to move vertically an endodontic file that is passive in the canal. The use of the file facilitates the penetration of the irrigant, leads to a more effective delivery of irrigant to the untouched canal surfaces and reduces the presence of air bubbles in the canal space, but does not improve the final cleaning. Another similar technique moves vertically a gutta-percha cone to working length with the canal filled with irrigant. Even this method, however, has not been found to improve the intracanal cleaning. For this purpose, in each case, wellfitting gutta-percha cones (increased taper) were more effective than cones with the standard taper (0.02). The use of endodontic brushes and of particular needles for endodontic irrigation with bristles on their surface is another technique suggested in order to move the irrigant more effectively within the canals. These systems have been shown to be valid in the removal of the smear layer from root canal walls and thus they can be recommended during irrigation with EDTA to improve their efficacy at the end of the preparation.

Machine-assisted agitation systems
The evolution of manual systems led to the introduction of instruments that can be rotated in handpieces at low speed inside the canal filled with irrigant. They are rotary brushes too large to be brought close to the working length; thus, they can be used effectively only in the coronal and middle thirds of the canal. Other similar instruments are files in plas-
Continuous irrigation during instrumentation

Recently, a new system for root canal preparation has been introduced to the market. This system uses a particular instrument with an abrasive surface that enlarges the canal via friction in a vibrating motion and allows irrigant to flow through the file itself. This system has shown excellent results in terms of respecting the anatomy and cleaning of difficult root canal anatomies, such as difficult isthmuses, oval canals or C-shaped canals. The low cutting efficiency of this system in some cases may limit its use in root canal preparation, but makes it an excellent additional technique to enhance the cleaning and disinfection of the root canal system at the end of the preparation. The concept of continuous irrigation was developed in the past with the use of mechanical instruments for sonic and ultrasonic preparation that could concurrently clean through the continuous release of irrigant. These techniques were then abandoned for various reasons related to the poor quality of the preparation itself.

Sonic activation

Sonic activation has been shown to be an effective method for disinfecting the root canals. The recent systems use smooth plastic tips of different sizes activated at a sonic frequency by a handpiece. The system seems to be able to clean the main canal effectively, to remove the smear layer and to promote the filling of a greater number of lateral canals. Another recently introduced technique uses a syringe with sonic vibration that allows the delivery and activation of the irrigant in the root canal simultaneously. Sonic activation differs from ultrasonic activation in that it operates at a lower frequency (1–6 kHz), and for this reason it is generally found to be less effective in removing debris than are ultrasonic systems.

Apical negative-pressure irrigation

As the irrigant must be in direct contact with the micro-organisms and canal walls to be effective, the accessibility of the irrigant to the whole root canal system, in particular in the apical third, is essential. In order to deliver the irrigant into the root canal for the entire length and to obtain a good flow of fluid, apical negative-pressure systems have been introduced that release and remove the irrigant simultaneously.

These systems consist of a macro-cannula for the coronal and middle portions and a microcannula for the apical portion, and the cannulas are connected to a syringe for irrigation and the aspiration system integrated with the dental unit (Fig. 3). During irrigation, a tip connected with a syringe delivers the irrigant to the pulp chamber without the risk of overflow, while the cannula placed in the canal pulls irrigant into the canal, through the aspiration system to which it is connected, and evacuates it through the suction holes. This system is intended to ensure a constant and continuous flow of new irrigant into the apical third safely and with a lower risk of extrusion. Most of the studies on this technique have shown that it is very effective at ensuring a greater volume of irrigant in the apical third and excellent removal of debris from this area and inaccessible areas, with results in the majority of cases similar to those of ultrasonic activation techniques. From a clinical perspective, apical negative-pressure systems can be effectively integrated with ultrasonic irrigation techniques because they act by different mechanisms. They can operate in synergy with the objective to obtain cleaner canals, especially in the apical third and the most inaccessible areas.

Laser activation

The interaction between the laser and the irrigant in the root canal is a new area of interest in the field of endodontic disinfection. This concept is the base of laser-activated irrigation (LAI) and photon-initiated photoacoustic streaming (PIPS) technology. The mechanism of this interaction has been attributed to the effective absorption of the laser light by NaOCl. This leads to the vaporization of the irrigant and to the formation of vapor bubbles, which expand and implode with secondary cavitation effects. The PIPS technique is based on the power of the Er:YAG laser to create photoacoustic shock waves within the irrigant introduced into the canal. When it is activated in a limited volume of liquid, the high absorption of the laser in NaOCl combined with the high peak power derived from the short pulse duration employed (50 µs) determines a photomechanical phenomenon. A study showed that there was no difference in bacterial reduction achieved by NaOCl activated by laser compared with only NaOCl. Another study investigated the capability of LAI to remove a bacterial biofilm created in vitro on the canal walls. This study found that it did not completely remove the biofilm from the apical third of the root canal and infected dentinal tubules. However, the finding that laser activation generated a higher number of samples with negative bacterial cultures and a lower number of bacteria in the apical third was a promising result regarding the effectiveness of the technique, and has been confirmed by a more recent study.
Additional disinfection systems

In addition to the above-mentioned systems that were able to activate the endodontic irrigants and to improve their cleaning capability, endodontic research is oriented toward the identification of alternative solutions that could further refine disinfection and assist in the destruction of biofilms and the elimination of micro-organisms. For this purpose, different substances and technologies have been investigated over time with different results.

Photoactivated disinfection

A new method recently introduced in endodontics is photoactivated disinfection. This technique is based on the principle that the photosensitizing molecules (photosensitizer, PS) have the ability to bind to the membranes of the bacteria. The PS is activated with a specific wavelength and produces free oxygen, which causes the rupture of the bacterial cell wall on which the PS is associated, determining a bactericidal action.\(^{34}\) Extensive laboratory studies have shown that the two components do not produce any effect on bacteria or on normal tissue when used independently of each other; it is only the combination of PS and light that exert the effect on the bacteria.\(^{34}\)

An endodontic system called light-activated disinfection (LAD) has been developed based on a combination of a PS and a special light source. The PS attacks the membranes of micro-organisms and binds to their surface, absorbs energy from light and then releases this energy in the form of oxygen, which is transformed into highly reactive forms that effectively destroy micro-organisms. LAD is effective not only against bacteria, but also against other micro-organisms, including viruses, fungi and protozoa. The PSs have far less affinity for the cells of the body; therefore, toxicity tests carried out did not report adverse effects of this treatment. Clinically, after root canal preparation, the PS is introduced into the canal to working length with an endodontic needle and is left in situ for 60 s to allow the solution to come into contact with the bacteria and spread through any structures, such as biofilms. The specific endodontic tip is then inserted into the root canal up to the depth that can be reached and irradiation is performed for 30 s in each canal (Fig. 4). This technique has proven to be effective in laboratory studies at eliminating high concentrations of bacteria present in artificially infected root canals.\(^{35}\) Care should be taken to ensure maximum penetration of the PS, since it is important that it come into direct contact with the bacteria, otherwise the effect of photosensitivity will not occur. In addition, LAD appears to be effective not only against the bacteria in suspension, but also against biofilm.\(^{5}\) Research is now directed toward evaluating the possibility of increasing the antibiofilm effectiveness of LAD, combining the benefits of photodynamic therapy with those of bioactive glasses and nanoparticles, which will be described later. Currently LAD is not considered as an alternative, but rather as a possible supplement to standard protocols of root canal disinfection already in use.\(^{5}\)

Laser

One of the main disadvantages of the current endodontic irrigants is that their bactericidal effect is limited primarily to the main root canal.
In the endodontic field, several types of lasers have been used to improve root canal disinfection: the diode laser, carbon dioxide laser, Er:YAG laser and Nd:YAG laser. The bactericidal action of the laser depends on the characteristics of its wavelength and energy, and in many cases is due to thermal effects. The thermal effect induced by the laser produces an alteration of the bacterial cell wall that leads to changes in osmotic gradients up to cell death. Some studies have concluded that laser irradiation is not an alternative, but rather a possible supplement to existing protocols to disinfect root canals. The laser energy emitted from the tip of the optical fiber is directed along the canal and not necessarily laterally toward the walls. In order to overcome this limitation, a new delivery system of the laser was developed. The system consists of a tube that allows the emission of the radiation laterally instead, directed through a single opening at its terminal end. The objective of this modification was to improve the antimicrobial effect of the laser in order to penetrate and destroy microbes in the root canal walls and in the dentinal tubules. However, complete elimination of the biofilm and bacteria has not yet been possible, and the effect of the laser has been found to be less relevant than that of the classical solutions of NaOCl. In conclusion, strong evidence is not currently available to support the application of high-power lasers for direct disinfection of root canals.

Ozone

Ozone is an unstable and energetic form of oxygen that rapidly dissociates in water and releases a reactive form of oxygen that can oxidize cells. It has been suggested that ozone may have antimicrobial efficacy without inducing the development of drug resistance and for this reason it was also used in endodontics. However, the results of the available studies on its effectiveness against endodontic pathogens are inconsistent, especially against biofilms. The antibacterial effectiveness of ozone was found not comparable and less than that of NaOCl.

Alternative antibacterial systems

Nanoparticles

Nanoparticles are microscopic particles between 1 and 100 nm in size that have antibacterial properties and a tendency to induce much lower drug resistance compared with traditional antibiotics. For example, nanoparticles of magnesium oxide, calcium oxide or zinc oxide are bacteriostatic and bactericidal. They generate active oxygen species that are responsible for their antibacterial effect through electrostatic interaction between positively charged nanoparticles and negatively charged bacterial cells, resulting in accumulation of a large number of nanoparticles on a bacterial cell membrane and a subsequent increase in its permeability associated with the loss of its functions. Nanoparticles synthesized from powders of silver, copper oxide or zinc oxide are currently used for their antimicrobial activity. In addition, nanoparticles can alter the chemical and physical properties of dentin and reduce the strength of adhesion of bacteria to the dentin itself, thus limiting recolonization and bacterial biofilm formation. In any case, the possible success of the application of nanoparticles in endodontics will depend essentially on the manner in which they can be delivered in the most complex root canal anatomy.

Bioactive glass

Recently, bioactive glass or bioactive glass-ceramics have been a subject of considerable interest for endodontic disinfection owing to their antibacterial properties, but conflicting results have been obtained.

Natural plant extracts

A current trend is the use of natural plant extracts, taking advantage of the antibacterial activity of polyphenolic molecules generally used for storing food. These compounds have been found to have poor antibacterial efficacy, but several demonstrate significant ability to reduce the formation of biofilms, although the mechanism by which this occurs is not clear.
Noninstrumentation techniques

The first trial of a method of cleaning without canal preparation was the noninstrumentation technique conceived by Lussi et al.40 This technique did not provide for the enlargement of the root canals because there was no mechanical instrumentation of the root canal walls. In fact, root canal cleaning was exclusively obtained with the use of NaOCl at low concentration, introduced and removed from the canal using a vacuum pump and an electric piston that created fields of alternating pressure inside the canal. These caused the implosion of the produced bubbles and hydrodynamic turbulence that facilitated the penetration of NaOCl into the root canal ramifications. At the end of this procedure, the canals were filled with a cement conveyed by the same vacuum pump. This system did not prove to be of substantial effectiveness and was never marketed.

Recently, a method has been developed for cleaning the entire root canal system through the use of a broad spectrum of sound waves transmitted within an irrigating solution to remove pulp tissue, debris and micro-organisms quickly. One study showed that this technique was able to dissolve the tissue tested at a rate significantly higher than that of conventional irrigation.4 More research is needed to determine whether this approach is effective in the root canal system with minimally invasive or no canal preparation.

Conclusion

According to current knowledge, endodontic pathology is an infection mediated by bacteria and in particular by biofilm. From a biological perspective, endodontic therapy must then be directed toward the elimination of micro-organisms and the prevention of possible reinfection. Unfortunately, the root canal system, with its anatomical complexity, represents a challenging environment for the effective removal of bacteria and biofilm adherent to the canal walls. Chemomechanical preparation involves mechanical instrumentation and antibacterial irrigation, and it is the most important phase of the disinfection of the endodontic space. The technological advances of instruments have brought significant improvements in the ability to shape the root canals, with fewer procedural complications. In the management of the infected root canal system, various antimicrobial agents have been employed. Furthermore, some clinical measures, such as an increase in apical preparation and a more effective system of irrigant delivery and activation of irrigant, can promote and make more predictable the reduction of intracanal bacteria, especially in complex anatomical and noninstrumented portions of the root canal system.

Editorial note: A list of references is available from the publisher.

about

Dr Gianluca Plotino is a senior lecturer in the Department of Endodontics and adjunct professor in the School of Dental Hygiene at the Sapienza University of Rome in Italy. He serves on the editorial boards of and is an official reviewer for several journals, and has organized several research groups worldwide. He is the author and co-author of more than 70 articles in international scientific peer-reviewed journals with high impact factors on different endodontic and restorative topics. Dr Plotino has given several lectures and courses worldwide, and he works in a private practice limited to endodontics and restorative dentistry in Rome.

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Prof. Gianluca Gambarini is Professor of Endodontics at the Sapienza University of Rome’s dental school. He is an international lecturer and researcher, and actively collaborates with a number of manufacturers all over the world to develop new technologies, operative procedures and materials for root canal treatment. Prof. Gambarini also works in a private endodontics practice in Rome.
As a practicing endodontist and manufacturer of endodontic instrumentation systems, it is fascinating to me to observe the initial evaluation of greater tapered rotary NiTi instrumentation as a paradigm improvement over traditional manual techniques morph into a far more cautious view where more and more evidence documenting its deleterious effects on the dentin is becoming increasingly evident.

To support that observation, research has found a correlation between the use of greater tapered rotating NiTi and the production of dentinal micro-cracks.\(^1\)\(^-\)\(^4\) Research has also found a decrease in resistance to vertical fracture; as the taper of the preparations increase, a clear gap between the actual pulpal anatomy that exists and the tools used to cleanse and shape them for obturation. It was noted by the last president of the AAE that he has seen a greater number of vertical fractures over the past 20 years, a time consistent with the introduction of greater tapered rotary NiTi instrumentation. His observations were supported by a large number of endodontists present at this meeting.

It is difficult to dismiss the reality that rotation of instruments within curved canals leads to torsional stress and cyclic fatigue, the two factors responsible for instrument separation. To reduce instrument separation, dentists have learned to do the following:

1. Establish straight-line access in the mesio-distal plane.
2. Use a crown-down technique that minimizes instrument engagement along length.
3. Employ heat-treated NiTi that are more resistant to cyclic fatigue.
4. Employ the instruments only once.
5. Create a more instrumented glide path prior to the use of rotary NiTi.
6. Remain centred when negotiating to length.
7. Use the instruments in interrupted rotation rather than continuous rotation.
8. Reduce the dimensions of the final canal preparation.

The above techniques and strategies are employed to reduce the stresses that occur in the instruments as they rotate within the confines of the canal. The emphasis is placed on maintaining the integrity of the instrument with minimal thought given to the impact they have on the integrity of the remaining root structure.

Straight-line access is purchased at the expense of removing additional amounts of coronal tooth structure. Crown-down preparations significantly increase the amount of coronal dentin removed so the instruments will contact a reduced amount of canal length at any one time. Heat treatment is a technique that increases the life span of the instrument without a comparable increase in the life span of the dentin, a tissue that is not amenable to technological improvements at present.

The instruments may be used once, but the impact of stress on dentin is cumulative whether new instruments are employed or not. A single instrument will simply work longer in a canal to achieve its goals of cleansing and shaping than any one instrument used with a multiple sequence technique.
Keeping instruments centred in canals that are highly oval, anatomy that is more the rule than the exception, keeps the instruments intact at the expense of compromised cleansing most often in the bucco-lingual plane. The new single file interrupted rotary systems are prone to instrument separation because they are still generating a minimum of 200 full rotations per minute, as a single instrument they are now doing the complete shaping after glide path creation and suffer from the same need to remain centered within the confines of the canal despite the presence of significant buccal and lingual extensions of pulpal tissue.

By instrumenting the canal to smaller tapers, the rotary systems either continuous or interrupted remove less tooth structure and are less prone to breakage. However, they are still confined to cantered preparations with little lateral brushing occurring leaving untouched buccal and lingual extensions of tissue.

If we go back to an earlier time prior to the introduction of greater tapered rotary systems, we basically relied on the use of K-files to shape the canals. From the start, these instruments are poorly designed to shape and cleanse canals. Their main defect in design is the incorporation of 30 predominantly horizontal flutes aligned along the 16 mm of working length.

Horizontal flutes can only shave dentin away with the pull stroke because it is only then that the cutting edges of the flutes are more or less at right angles to the plane of motion, a requirement for the removal of dentin. This same flute alignment unfortunately is designed to impact dentin at the tip of the instrument when it is directed apically.

Losing length when using K-files is familiar to most dentists, especially when curves exist in the apical third. Rather than employing instruments with predominantly horizontal flute orientations as our initial tools, we should be using instruments with predominantly vertical flute orientations, similar to the designs incorporated into most rotary systems.

A predominantly vertical flute orientation will shave dentin from the canal walls with the first clockwise stroke. When the instrument is removed and reintroduced into the canal, the vertically oriented flutes will tend to glide past any debris present rather than impacting it apically. These instruments are defined as reamers.

Essentially, we are using a watch-winding motion, similar to that used with K-files, but with far greater efficiencies and far less likelihood for apical blockage. We further improve the mechanics by incorporating a flat along the length of the reamers further reducing engagement and creating an instrument that now has two columns of cutting chisels that work in both the clockwise and counter clockwise motion.

A watch-winding motion eliminates the full rotations that lead to excessive torsional stress and cyclic fatigue that produce the instrument separations we want to avoid. The hand fatigue associated with the use of K-files is completely eliminated when generating the watch-winding motion in a 30- to 45-degree reciprocating handpiece. The speed of the procedure is significantly increased because the reciprocating handpiece has the added advantage of oscillating at 3,000 to 4,000 cycles per minute.

For those dentists using greater tapered rotary NiTi systems, the goal of the K-files was limited to creating a glide path producing an 02 tapered centred space up to at most a 20. The relieved reamers also have that function, but with the power of a reciprocating handpiece generating oscillations of 3,000-4,000 cycles per minute, the instruments have the added ability to vigorously work the buccal and lingual extensions of highly oval, sheath-like pulpal anatomy.

One need not be concerned about the reduced flexibility of stainless steel relieved reamers. In their smaller dimensions they are easily flexible enough to negotiate complex curved canals. As the thinner, highly flexible instruments faithfully enlarge the original canal anatomy free of distortions, they are defining a pathway that the somewhat larger and less flexible relieved reamers will then faithfully follow. The goal in most situations is to produce an apical preparation of 30 applied to all the walls of the canals, be they round or not. Please realize that this goal will ultimately produce a larger version of the original canal anatomy rather than the imposition of a large conical shape that bears little relationship to the original anatomy.

For the most part, we do not want to exceed a taper of 04. Such a conservative preparation preserves coronal dentin and in combination with the relieved reamers allows us to remove tissue from those thin extensions that are off limits to rotary NiTi instrumentation. The system we are defining is based primarily on 02 tapered stainless steel relieved reamers (Fig. 1). After the glide path creation using the relieved reamers (SafeSiders), crown-down preparations are no longer necessary. Rather the final preparation is a simple extension of instrumentation that widens the canal from a 20/02 preparation to a maximum of 30/04 in most situations (Tango Endo, Fig. 2), a final result that requires only two more instruments after the 20/02 preparation has been achieved.
Given our clinical experience, along with the insights that are being documented from recent research, we can make the following conclusions regarding the use of this approach to endodontic instrumentation:

1. Instrument separation is virtually eliminated, producing a much more favourable mind-set for the dentist.
2. Dentinal micro-cracks associated with rotary NiTi are not associated with the short amplitudes of motion produced by the 30- to 45-degree reciprocating handpieces.1–4
3. Lesser tapered preparations reduce the amount of coronal dentin being removed increasing the resistance of the tooth to the forces that produce vertical fractures.1–4
4. The thin O2 tapered stainless steel relieved reamers are capable of removing tissue from the often thin buccal and lingual extensions that are not touched by the greater tapered systems and where canal blockages occur when using K-files.
5. The recommended relieved reamers will negotiate to the apex with far less resistance than the traditional use of K-files.
6. Due to their limited exposure to torsional stress and cyclic fatigue, a result of the 30- to 45-degree reciprocating handpieces, the instruments may be used several times before replacement, yielding dramatic savings.5

In our endodontic practice, the feeling of security is most important. We seek out ways to produce highly effective predictable results. For us, that means no instrument separation as a cause of concern with the full appreciation that our procedures must primarily maintain the original integrity of the remaining tooth structure as much as possible.

References


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Matching gutta-percha cones to NiTi rotary instrument preparations

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Introduction

With the widespread use of rotary nickel-titanium (NiTi) instruments, matched-taper gutta-percha (GP) cones of greater tapers were developed to make root canal obturation techniques easier and more predictable, and possibly to improve quality of 3-D fillings. Nowadays, many manufacturers produce matched-taper GP cones intended for use with a specific instrumentation technique. Consequently, the single-cone technique has regained popularity, since a single matched-taper cone can produce a satisfactory 3-D fill, and warm vertical techniques benefit from the use of a matched-taper master cone by a reduced risk of voids inside the filled endodontic space.

However, the larger number of and variability in design and dimensions of commercially available NiTi instruments and GP cones of greater tapers can easily create confusion among practitioners, especially if using instruments and cones of different brands. If the GP cones selected do not precisely match with the NiTi instruments used, the whole concept fails and in many cases the GP cones do not reach the desired working length or do not precisely fill the apical preparation.

In order to understand how matched-taper GP cones should work, it is important that clinicians be aware of the differences in size, taper, design and manufacturing process of these products. Even if these factors are usually taken in account when a manufacturer produces matched-taper GP cones to be used with a specific instrumentation technique, the goal of the present paper is to discuss all of these variables and give clinicians a better understanding of the possible clinical problems they may encounter in cone fitting and practical solutions to these.

Size, tolerance and manufacture of GP cones

Conventionally, GP cones are hand rolled, a manufacturing process that is neither very precise nor consistent. Therefore, according to ISO standards, the tolerance allowed for GP cones is 0.05 mm, much larger than the tolerance allowed for endodontic instruments produced by grinding or twisting (0.02 mm). This has always been a problem in endodontics and it explains why correct fitting of the master cones in all techniques (single-cone, lateral condensation, warm vertical condensation, continuous wave of obturation) has always been described as a fundamental step in the procedure.

With the conventional ISO 0.02-tapered cones, the problem was mainly related to the lack of precision of the tip of the GP cones. Therefore, GP tips needed to be manually adjusted to fit the apical preparation with good retention (tug-back) in order to avoid underfilling or overextension of cones through the apical foramen. The same procedure was needed for non-standardized GP cones with feathered tips. For this reason, specific calipers and instruments to cut GP cones precisely were developed.

With the introduction of GP cones of greater tapers, a problem related also to the taper arose. These new GP cones can be grouped into two categories: uniform and nonuniform taper. The former cones are usually marketed as 0.04- or 0.06-tapered cones, while the latter are usually marketed in association with a brand name related to a specific instrumentation technique (e.g., ProTaper cones, DENTSPLY; and TF Adaptive [TFA] cones, Kerr). Development of these cones was necessary, since nowadays more NiTi ro-
rotary instruments have a nonuniform taper (e.g., ProTaper; and HyFlex EDM, Coltène/Whaledent) or a working part smaller than 16 mm (e.g., Twisted Files [TF], Kerr; and TFA).

**Tip sizes and tapers of NiTi instruments**

While some instruments have a nonuniform taper, the majority of endodontic NiTi rotary instruments have a uniform taper, and the associated techniques are intended to create at least a 0.04- or 0.06-tapered preparation. For this reason, GP cones of greater tapers are usually sold in 0.04 and 0.06 tapers.

However, NiTi instruments with the same nominal size and taper may not have the same dimensions and consequently not create an identical root canal preparation, since the length of the working part may be different (Fig. 1). For example, in a 25.06 K3XF instrument (Kerr; or other instruments, including RevoS, MICROMEGA; ProFile, DENTSPLY; and Race, FKG Dentaire), the working part is 16 mm, while in a 25.06 TF instrument, it is 10 mm. Even if the taper and tip sizes are the same, a 25.06 K3XF instrument will enlarge the root canal to 1.21 mm. This calculation can be made as follows: 0.06 mm increase for each millimeter, multiplied for 16 mm = 0.96 mm + 0.25 mm tip size = 1.21 mm. In contrast, a 25.06 TF instrument (a file with a reduced working part) will enlarge the canal to a lesser extent: 0.85 mm (0.06 mm × 10 mm = 0.60 mm + 0.25 mm tip size = 0.85 mm).

Similar differences can be found between any NiTi instrument with a conventional 16 mm working part compared with any other instrument with a reduced working part. NiTi instruments with a shorter working part are widely used because a shorter working part creates less stress during instrumentation by reducing taper lock and torsional stress in the coronal part, the largest section of the instrument. With a lower operative torque, efficiency and safety are more easily improved. For the same reason, some instruments have a nonuniform taper, which usually is smaller in the coronal part, in order to gain more torsional strength in the apical part and more flexibility in the coronal part. Nevertheless, instruments with shorter working parts or nonuniform tapers need GP cones with the same design and dimensions in order to allow a good match between the prepared canals and the obturating materials.

**Matching instruments with nonuniform tapers with GP tapered cones**

The same differences in dimensions previously described between instruments (e.g., K3XF compared with TF) can be found between 0.04-/0.06-tapered GP cones and cones with nonuniform tapers (e.g., ProTaper and TFA cones). The first few millimeters are usually similar, but in the middle or coronal part, the GP cones might be much wider. Therefore, if a 0.04-/0.06-tapered GP cone is used in a root canal prepared with nonuniform taper instruments, the GP cone will probably not go to working length, because
of the greater dimensions of the cone in the middle or coronal part. This could be considered GP taper lock.

This is a different problem to that experienced by dentists in the past, which was mainly related to cone fitting in the apical part, and consequently requires a different approach. Choosing a cone with a smaller tip size may not solve the problem, while choosing a smaller-taper cone may significantly increase the risk of iatrogenic errors such as underfilling and overextension of the cone through the apical foramen, because the tug-back in the coronal part does not allow for correct fitting of the apical part of the cone.

Therefore, the best and easiest solution is to choose brand-associated GP cones that precisely fit the root canal preparation achieved by the specific NiTi instruments and allow for ideal 3-D filling and good apical tug-back. However, with the K3XF system, clinicians could use both types of cones (i.e., the 0.04–0.06 cones or TF/TFA cones) because they will both fit the root canal preparation in the apical and middle thirds well, where tug-back and 3-D matching are more critical.

More clinical hints

Thus far, dimensions and sizes have been discussed to help clinicians understand the difficulties in matching instruments and cones. However, there are also clinical ways to seek to solve problems encountered during these procedures. The following advice may be useful for both instruments with nonuniform tapers and many instrumentation techniques.

Create greater coronal flaring

If a GP cone does not perfectly match the root canal preparation and thus does not reach the working length, one possible solution is to increase the coronal flaring by brushing with the last instrument used. By doing so, the NiTi instrument will increase the dimensions of the prepared canal in the coronal part, solving the problem of GP taper lock.

Ensure correct apical fit

Clinicians may experience two different clinical problems in the apical fit: the need for a better apical tug-back, which may require slightly cutting the tip of the master cone, and the fit related to the amount of canal transportation. The first situation may occur when, owing to the different dimensional tolerance, a GP cone is slightly smaller than the nominal size, increasing the risk of overfilling during obturation. In such a case, the advice is to increase the dimensions of the master cone slightly by cutting 0.5–1 mm off the tip, or ideally to recalibrate the master cone precisely using a tip-snip device. This can also occur if a canal is slightly overinstrumented (e.g., owing to an error in determination of the working length or in the position of the rubber stop on the file). In such a situation, the apical constriction would have been modified and the cone fit would have to compensate for the error by increasing the tip size of the GP master cone.

Some NiTi instruments (HyFlex; TFA; TRUShape, DENTSPLY; NEONITI, NEOLIX; etc.) are significantly more flexible than the majority of competing NiTi rotary instruments. As a consequence, they tend to follow and maintain the original trajectory of the root canals more precisely, minimizing canal transportation. Canal transportation frequently occurs when a rigid file is inserted into a curvature and tends to straighten it by cutting more in the inner part of the curvature coronally and in the outer part apically. However, this error, which can affect the quality of debridement, makes insertion of master GP cones easier, especially when complex, double or triple curvatures are present. For this reason, clinicians using such flexible NiTi instruments may experience slightly more difficult insertion of the master GP cone to the working length. If this problem occurs, once again slightly increasing flaring by circumferential filing can help.

Conclusion

It may be concluded that clinicians who use instruments with nonuniform tapers or with reduced working parts should preferably use brand associated GP cones that perfectly match with the prepared canals. By doing so, fitting the master GP cone becomes much easier and more predictable. In the very few cases in which problems still arise, the clinical hints provided may help practitioners to understand the problem and find a proper solution._

about

Prof. Gianluca Gambarini is Professor of Endodontics at the Sapienza University of Rome’s dental school. He is an international lecturer and researcher, and actively collaborates with a number of manufacturers all over the world to develop new technologies, operative procedures and materials for root canal treatment. Prof. Gambarini also works in a private endodontics practice in Rome.
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Tooth ache is hard to bear

Author: Annika Keilhauer, Germany

Normally polar bears seem to have an unshakeable constitution: moving across snow, ice and open water to hunt for food the endangered species endures extreme conditions. A necrotic pulp nonetheless is intolerable for both humans and those magnificent animals. Lars, father to the world’s most famous polar bear cub Knut, recently underwent surgery in Aalborg Zoo to treat some serious endodontic problems.

RCTs rank among the not quite so popular dental treatments for both patients and general dentists. Sometimes patients literally have to be carried to the surgery like Lars, a full-grown polar bear that was suffering from two inflamed fangs due to complicated crown fractures. In order to get the bear ready for the comparatively risky endeavour, it took ten people to lift the anaesthetised animal onto the operating table. However, the team of veterinary dental specialists encountered even more challenges: the affected root canals were extremely long and curved making the RCT more challenging. The traumata to the teeth were estimated to have taken place some time ago and the pulp tissue was expected to be necrotic.

Unusual circumstances

The patient in this case report is by far not unknown to the public: Twenty-one-year-old polar bear Lars was born in captivity in Hellabrunn Zoo and lived in various other German zoos. In 2006 he fathered a polar bear cub that rose to absolute celebrity status—little Knut turned into an international media phenomenon and generated a lot of interest in captive polar bears and animal welfare in general. Since the beginning of 2015, Lars lives in Aalborg Zoo in Denmark. People still care about Knut’s family and their fate. Several Danish TV stations and newspapers came to report on the treatment of the zoo's wildly popular inhabitant, who even sports his own private fan club.

Anaesthesia

To anaesthetise the polar bear it was first darted with strong sedatives by the zoo’s veterinarian Trine Hammer Jensen. After ten minutes the animal was ready to be transported to the operating area.
safety and to make use of precious time the dental team did not want to move the polar bear far from his compound. The senior veterinarian, Hanne Kortegaard from the Department of Clinical Veterinary and Animal Science, Copenhagen University, operated out in the open on an improvised table made of various Euro-Pallets covered with a mat. The structure should be stable enough to carry a stately weight of 400 kg.

All keepers, doctors and medical experts assisting in the procedure joined forces to lift the huge animal (resting in a special canvas) to the table top. When the bear was finally in place, the specialists had to act swiftly to proceed with the actual endodontic treatment. Being under general anaesthesia for a long time may be dangerous to a patient. To minimise this risk it was decided not to do both RCT at the same day, but to postpone the treatment of the second tooth for some weeks.

Getting down to business

Access to the pulp chamber was gained by opening the already broken tooth at the fracture site. A portable X-ray machine and indirect radiograph system helped to locate and visualise the root canal system during the operation. The canal was extremely long and curvy. So-called tiger and bear files were used for the preparation, which have an overall length of 120 mm. Nevertheless, even with those instruments it was not possible to reach the apex due to the curvature of the tooth. A second opening at the mesial side of the tooth a few millimetres above the gingiva became necessary to secure a straight access to the apex and a thorough preparation of the canal. Working length from this point of entry still added up to 65.5 mm. The file with the biggest diameter used in the procedure was an ISO 80. Although this file was yet too small in diameter for the wide canal, it at least did not transport any debris into the system when the canal was cleaned and shaped.
Apart from the extra-long endodontic files and veterinary paper points especially developed for the treatment of animals, all materials used during the surgery were common dental products, which can be found in every human dental surgery as well. For the first rinsing of the canal NaOCl 0.5% was used. Amongst other things even short blades of grass and a fish bone were discovered in the root canal system. After the canal had been cleared of all debris and necrotic tissue, the irrigation protocol was finalised with CanalPro NaOCl 6% and sterile saline. Before obturation the canal was thoroughly dried with the above-mentioned paper points and thin sterile cotton sticks.

**Reliable filling in tough conditions**

In order to create a permanent, durable filling, the veterinarian eventually needed a modern filling system with excellent flow properties. Swiss dental specialist COLTENE recently introduced an intelligent obturation material that is quick to use with process times of only 10 to 15 minutes. GuttaFlow bioseal combines fluid gutta-percha with a suitable sealer at room temperature. The bioactive material thereby actively supports the regenerative processes in the tooth. In contact with fluids, it provides natural repair components such as calcium and silicates. It furthermore sets in motion corresponding biochemical processes that provide additional support in the regeneration of the root canal. After curing the innovative material can form so-called hydroxyapatite crystals on the surface. These crystals improve adhesion significantly and help to stimulate the regeneration of bone and dentin tissue in particular. Until now, only dental materials such as MTA or bioactive exhibited similar regeneration-supporting properties. However, the disadvantage of these traditional materials is primarily their long curing time or complicated handling.

The catalytic effect triggered by the special composition of GuttaFlow bioseal was exploited in order to create a long-lasting solution for a denture that is exposed to an enormous masticatory force. Dimensions in the anatomy of a full-grown polar bear are slightly different to those of the human body, too. A feline urinary catheter was adjusted to prolong the mixing tip of the gutta-percha syringe in order to reach further down the canal. Whereas dentists use less than 1 ml of material on human patients, practically half of the content of a 5 ml automix syringe had to be used to fill the root canal system. After the root canal has been securely sealed with GuttaFlow bioseal and a thin layer of glass ionomer, the restoration was topped off with a composite built up. The dual-curing bulk composite Fill-Up! allowed to fill the two access cavities very quickly and efficiently. Light-curing only required 5 seconds and the marginal integrity was high due to the low shrinkage forces. In Lars’ case it was again vital to use materials that are fast to apply, but yet reliable and robust enough to defy comparatively tough conditions. Using dental material on carnivores and large animals can become a real endurance test for the substances employed in the restoration. The veterinary dentist in charge was thus looking for high-quality products with a proven track record that would meet those strong criteria.

**A promising prognosis**

After three hours the polar bear finally got off the operating table again. Two months later, another surgery was scheduled to perform a root canal treatment in his second broken fang. This time the pulp chamber was accessed immediately from the mesial side of the tooth because the team already knew about the problem the long, curved root canals posed. On the one hand this procedure helped to reach the pulp chamber much quicker, on the other hand the removal of more dentin naturally weakens the tooth. Again, an extra reliable and strong filling material was needed to create a durable solution. The masticatory forces working in the mandible of a polar bear even chal-
lenged the R & D department of COLTENE as dental materials normally function on a much smaller scale. Luckily, the bulk composite Fill-Up! allows to fill cavities of more than the average four to five centimetres still using the single-layer technique.

Thanks to the experience of the first surgery, the second endodontic treatment ran without any complications. After two hours the right mandibular canine tooth was successfully operated too. The left mandibular canine was radiographed for follow-up. Within the next months the supervision of Lars’ eating habits will reflect the results of the two RCTs. A post-operative X-ray documenting the status quo like in a human patient would mean another anaesthesia for the huge animal and will be executed in 9 to 12 months. At the moment the polar bear is recovering fast and chewing on regular food again.

Fortunately, the zookeepers in Aalborg were versed enough to react fast: they spotted the apparent problems the polar bear had with his fangs first. Acknowledging a dental problem in a wild animal can be a challenge and will often be overlooked. Educating caretakers at the zoos about dental problems and the effect this has on the animal, will protect these creatures against discomfort and pain and improve their quality of life since early action can be taken. In the small animal dental clinic at Copenhagen University Hanne Kortegaard sees mostly cats and dogs and caters for their endodontic problems and needs. European and American veterinary dentists are comparatively well-trained given the level of practical education they receive: in their training programme they have to treat several endodontic cases as well as handle a large number of extractions, maxillofacial surgical cases as jaw fractures or cancer surgery, orthodontic, prosthodontics and restoration cases. Dentists helping human patients can in fact benefit a lot from the considerable experience of their veterinary colleagues.

Conclusion

Operating in extreme conditions clearly demonstrates how much even a skilled and experienced dentist relies on dependable material that is easy to handle. Time constraints sometimes add extra pressure on the treatment as such. Innovative 2-in-1-filling systems combine sealer and gutta-percha for a tight seal of the root canal. State-of-the-art composites also add to the success of the restoration. With the help of tried and tested material endodontic problems can be cured really fast, which means that nobody has to endure tooth ache—whether it is sensitive human beings or stout Nordic creatures.

about

Hanne Kortegaard works as a Seniorvet in the surgery group at the Department of Veterinary Clinical and Animal Sciences at Copenhagen University, Denmark. She specialises in veterinary dentistry, mainly in small animals and helps in treating zoo animals in Denmark whenever called. Since 1998 Kortegaard has been teaching veterinary students in veterinary dentistry and surgery.

Polar bear Lars was born in 1993 in the Zoo Hellabrunn, Munich. In line with the European Endangered Species Programme (EEP) he lived in various German zoos, i.e. Hellabrunn, Berlin, Wuppertal and Rostock. In 2015 he was moved to the Aalborg Zoo in Denmark. The polar bear (Ursus maritimus) is classified as a so-called vulnerable species with varying estimates of global population numbers. In wildlife, polar bears face growing habitat loss due to climate change, pollution and oil and gas development.

Website www.coltene.com
Documentation is also available on YouTube under the title “Endo Treatment Polar Bear Lars, COLTENE 2015”.

unusual endodontic treatment feature
Vista Dental Products is revolutionizing composite delivery with its new line of Therma-Flo products, which the company says are uniquely engineered to utilize heat for optimal performance of any preferred composite material. The Therma-Flo Composite Warming Kit is designed to improve the flowability of highly filled composites more than 100 per cent through the use of heat. With the Therma-Flo Warming Kit, your preferred highly filled composite will perform like a flowable, providing greater adaptation to the cavity walls, according to Vista. Scientific research indicates heating composite material aids in the reduction of curing time and improves polymerization, which reduces voids in the restoration, the company says. Heated composite material is much easier to manipulate, making placement fast and effortless.

Vista Dental Products
2200 South Street
Racine, WI 53404
USA
www.vista-dental.com

Isolite Systems provides three state-of-the-art product solutions for every practice, every operator: Isolite, illuminated dental isolation system; Isodry, a non-illuminated dental isolation; and the new Isovac, dental isolation adapter. Using the Isolation Mouthpieces, all three dental isolation products isolate upper and lower quadrants simultaneously while providing continuous hands-free suction. This allows a positive experience where the patient no longer has the sensation of drowning in saliva/water during a procedure and the practitioner can precisely control the amount of suction/humidity in the patient’s mouth. Isolite Systems’ dental isolation is recommended for the majority of dental procedures where oral control and dental isolation in the working field is desired. It has been favorably reviewed by leading independent evaluators and is recommended for procedures where good isolation is critical to quality dental outcomes.

Isolite Systems
111 Castilian Drive
Santa Barbara
CA 93117
USA
www.isolitesystems.com
The S1 System

The S1 System is a single file system using a reciprocating motion—wi5h new technology we are making root canal treatment even simpler. The design makes it easy to use applying steady movements, for the best ergonomics. We simplify endodontics and also makes it more cost-effective. The S1 contra-angel handpiece with its reciprocating motion, has a unique design with an integrated gearbox and rotates 180° clockwise and 30° anti-clockwise alternately—a smart solution which allows you to connect the contra-angle handpiece directly to your dental unit with no need for an external motor. The contra-angle handpiece has also been designed to make your work easier; the angel of the head is 90°, giving you more freedom in the area around the molars.

In contrast with many of our competitor’s products creating reciprocating motion which use an external motor, cord and foot pedal—an unnecessarily complicated procedure.

The motorless concept also means the S1 System is cost-effective and meets today’s hygiene standards.

Fotona launches ST PRO LightWalker dental laser

Fotona launched its new ST PRO LightWalker dental laser at the Chicago Dental Society’s 151st Midwinter Meeting, held in February. According to the company, the ST PRO is a full-featured, hard- and soft-tissue dental laser with many of the features of the award-winning LightWalker ATS. The ST PRO is an ultra fast Er:YAG dental laser capable of removing cavities without the need for shots and local anaesthetic, especially for children, in most cases, according to the company. The ST PRO also performs the patented and widely researched and acclaimed PIPS laser root canals, a wide range of atraumatic bone procedures and non-invasive, blood and suture free soft tissue procedures.

According to the producer, the ST PRO includes features not available in competing systems, including:

- Powerful 12 watts of Er:YAG energy for ultra fast cutting.
- Large, user-friendly touch screen with a wide range of easy-to-use presets.
- The highly reliable, ergonomic and efficient Optoflex delivery system.
- High-visibility green aiming beam.
- Built-in air supply, eliminating the need for external air connections/supplies.
- Optional Quantum Square Pulse (QSP) and SMOOTH mode for advanced clinical procedures, such as the non-invasive Nightlase snoring treatment.

Sendoline’s unique S-profile with its double cutting edges is extremely effective in the root canal with the S1 System’s reciprocating motion. The instrument has a non-cutting tip, making it easier to hold it steady in the centre of the root canal. The instruments rotation 180° clockwise and 30° anti-clockwise alternately—and the nickel titanium alloy’s elasticity and flexibility minimize the risk of instrument fracture.

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187 66 Täby
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Roots Summit 2016
Premier global forum for endodontics takes place in Dubai

This year’s ROOTS SUMMIT, which has drawn dental professionals to various locations all over the world in the past decade, will take place from Nov. 30 to Dec. 3 at the Crowne Plaza Dubai hotel in the United Arab Emirates. Aimed at updating participants about the latest in endodontic treatment, an unparalleled series of lectures and workshops will be held by global opinion leaders in the field.

Previous ROOTS SUMMITS have been held in Canada, the US, Mexico, Spain, the Netherlands, Brazil and last year in India. These meetings have been known for the strength of their scientific programs and their relevancy to clinical practice. The lectures, workshops and hands-on courses scheduled for this year’s meeting will be no exception. More than 15 distinguished experts are presenting during the conference.

For the summit in Dubai, the organisers have partnered with Dental Tribune International (DTI) and the Dubai-based Centre for Advanced Professional Practices (CAPP) for the first time. With its international network, composed of the leading publishers in dentistry, DTI reaches more than 650,000 dental professionals in 90 countries through its print, online and educational channels, as well as a number of special events.

Over the past decade, CAPP has been able to establish first-class standards for continuing dental education programs not only in the UAE but also across the Middle East. Since 2012, CAPP has been affiliated with DTI as a strong local partner in the Middle East.

Based on the successes of previous ROOTS SUMMITS, the organisers anticipate a large turnout for this year’s meeting. Various sponsorship opportunities are available, including booth space, as well as sponsorships of workshops, hands-on courses, meeting bags and social events.

Online registration for the ROOTS SUMMIT is now open at www.roots-summit.com. Dental professionals are also invited to join the ROOTS Facebook group and like the ROOTS SUMMIT 2016 Facebook page.
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Dental professionals from across the country and around the world gathered in San Francisco April 6 to 9 for AAE16, the annual meeting of the American Association of Endodontists. There was plenty of excitement at Moscone Center West. The meeting offered attendees a great opportunity to learn, to explore new products and services, and to connect with fellow specialists.

A lot of planning was put into this year’s meeting, according to AAE President Terryl A. Propper. “I want all of our attendees to return to their practices, schools or residencies with new enthusiasm and ideas to provide the best patient care and support the specialty,” Propper said, in a press release announcing the meeting.

There was plenty to learn at the meeting—and plenty of ways to learn. CE credit was available by attending the many lectures and workshops, plus the general session, submitted presentations, poster research and table clinics, and even “CE Express” mini lectures.

“Not everyone learns in the same way, so we’re excited to introduce new programming this year to meet the needs of all attendees,” said Propper.

This year two new educational tracks—Interdisciplinary Care and Derailment—were added. The Interdisciplinary Care track offered different perspectives on orofacial pain, otolaryngology and pharmacology. Derailment delved into things that can go wrong each day—from managing material extrusion, to removing broken or separated instruments.

On the exhibit hall floor, more than 100 companies showcased the latest in endodontic equipment, materials and supplies.

At Coltene Endo, attendees could learn about the new HyFlex EDM (electronic discharge machining)
file system. Reps Brad Morrison and Frank Reid told Dental Tribune that the system was designed with two key objectives in mind: flexibility and fracture resistance.

Roydent Dental Products featured its wide array of products, including MAP (Micro Apical Placement) Systems. These kits are designed to provide an efficient method for placing root canal repair materials by orthograde or retrograde obturation.

At Henry Schein/EndoVision attendees could learn more about how Simplifeye can enhance your office’s communication.

Dental Cadre was displaying the Terauchi file retrieval system.

HuberMED had a number of innovative products, including a BonePen Kit and an Implant removal Kit.

Komet USA was presenting the Komet Endo Rescue Kit, for safe and effective removal of instrument fragments. According to the company, the F360 file features a “Double-S” crosscut design, for increased flexibility and cutting efficiency.

Also on the exhibit hall floor, “To the Point” corporate lectures were offered on a wide variety of topics.

about

American Association of Endodontists
headquartered in Chicago, AAE represents more than 8,000 members worldwide. Founded in 1943, the association is dedicated to excellence in the art and science of endodontics and to the highest standard of patient care. AAE encourages its members to pursue professional advancement and personal fulfillment through education, research, advocacy, leadership, communication and service.
2016

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www.ifeaendo.org

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23–26 June 2016
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www.nobelbiocare.com/global-symposium-2016/

19th World Congress on Dental Traumatology and the 5th Trans–Tasman Endodontic Conference (WCDT2016)
11–13 August 2016
Brisbane, Australia
www.wcdt2016.com

SkandEndo 2016
25–27 August 2016
Copenhagen, Denmark
www.skandendo.com

FDI Annual World Dental Congress
7–10 September 2016
Poznan, Poland
www.fdi2016poznan.org

Italian Academy of Endodontics (AIE) – 24th National Congress
6–8 October 2016
Pisa, Italy
www.accademiatitalianaendodoncia.it

3rd PanDental Conference and Exhibition 2016
11–12 November 2016
Birmingham, United Kingdom
www.pandental.co.uk

German Society of Endodontontology and Traumatology (DGET) Annual Meeting
17–19 November 2016
Frankfurt/Main, Germany

Greater New York Dental Meeting
New York, USA
25–30 November 2016
www.gnydm.com

ROOTS Summit
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www.roots-summit.com

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www.oegendo.at
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We can run an unusually long article in multiple parts, but this usually entails a topic for which each part can stand alone because it contains so much information.

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Questions?

Magda Wojtkiewicz (Managing Editor)
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