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Welcome to the Roots Summit Dubai 2016!

On behalf of the organising committee, it is my sincere pleasure to welcome you to our Roots Summit Dubai 2016 meeting: “Endodontics these days is better than ever.”

We have built a worldwide Endodontic community through the use of social media, specifically in our case, Facebook. Our Facebook Group, ROOTS is a leader in online discussion with well over 22,000 members. This allows us to exchange ideas, clinical cases, treatment options, and discuss our profession with people from multiple continents and countries on a daily basis, 24/7.

Let me share some of the exciting things that we have prepared for you.

Dubai 2016 is our 12th Roots Summit. By moving to Facebook, ROOTS has grown in its ability to support the creative and educational basis of our specialty. This is of paramount importance for our continued success as clinicians.

Steve Jones and Freddy Belliard have been working tirelessly to organise this year’s event. My role is programme director for this edition. Together, we have organised a unique event, where we will have 20 of the top opinion leaders in Endodontics. These top-level clinicians will present and share their daily work with the attendees.

We have the opportunity to make the Roots Summit event not only a clinical and scientific event. This is an opportunity to gather together people from all over the world. One of the strengths of ROOTS over the years has been having so many people from diverse locations and backgrounds get to know each other better, exchange ideas, develop and strengthen friendships, and help improve our profession for the benefit of all.

We have organised a series of hands-on courses where the participants will be able to observe and learn from the best in their areas of expertise, and to practice the new techniques with the help of our great lineup of clinicians. We hope that you will take advantage of this great opportunity. Our speakers spend most of their time traveling the world helping to improve the efficiency, and more importantly raise the standard of endodontic practice. Having them all in one place will be one of the best endodontic learning opportunities of the year.

In addition to a very full programme of speakers, we will also have a period on Saturday afternoon for oral presentations. We wanted to provide the time and opportunity to our community members to present others what they are doing in their academic areas or Endodontic offices. We will have also poster presentations for all of those who would like to share their knowledge with us.

You are invited to explore this meeting and discover for yourself the great opportunity to be found here. However, the real keys of the Roots Summit event experience lie within each of you and every single participant. Share your experiences and you will meet active and engaged learners who are breaking new ground and engaging in the world of Endodontics with the purpose as they seal to find powerful and effective ways to improve their knowledge.

Please enjoy yourself, learn and have fun!

Dr David E. Jaramillo
Programme Director
Root Summit, Dubai 2016
Welcome to the Roots Summit Dubai 2016!
Dr David E. Jaramillo (Guest Editor)

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The role of the operating microscope
Dr Anthony C. S. Druttman

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Manager versus clinician

How to manage expectations of the management role and turn it into success

Author: Lina Craven, UK

Practitioners’ expectations of the kind of manager they want for their practice vary considerably in terms of experience and skills. How guilty are you of promoting a nurse or receptionist to a management role without determining the skills gap and providing the necessary training? It is a common scenario in our industry.

Practitioners have a responsibility to their teams and to the financial success of their practices to appoint someone who either has the necessary skills or has the capacity to learn them in the appropriate time frame. How realistic are your expectations and how can you ensure your management role results in success?

Creating and managing realistic expectations

Expectations are difficult to control and impossible to turn off. According to Brazos Consulting, “Expectations are deeper and broader than ‘requirements’. Expectation is your vision of a future state or action, usually unstated but which is critical to your success.” By learning to identify and influence what you expect, and by ensuring it is clearly communicated, understood and agreed with your manager, you can dramatically improve the quality, impact and effectiveness of your business.

Expectations are created by many different circumstances. It may be something you said or the way that you said it, something you or someone else did, or an expectation of your prospective manager based on his or her previous experience. The vital point here is that expectations, whether right or wrong, rational or otherwise, are not developed in a vacuum. You should consider instances when you were let down by your manager and ask yourself how that expectation was derived. Was it based on an agreement with your manager after a discussion or was it based on something you said or thought in passing? In retrospect, you may wonder how realistic that expectation was and why you thought your manager was in the strongest possible position to fulfill it.

In my experience, the following scenarios are typical of how unrealistic expectations are created:

- The practitioner is busy and needs someone to take charge. He or she chooses the "best of the bunch", hoping he or she will learn on the job.
- The new manager has his or her expectations of the job and these are often unrealistic.
- No detailed job description or objectives are ever provided. No on-the-job or any other type of training is provided; the practitioner simply assumes the manager will learn as he or she goes along.
- The manager is excited about the new position. For some, the empowerment, the title and the kudos mean a great deal; for others, the challenge and the task at hand mean more. When reality hits, so does the realisation that the original motivating factors are no longer as important.
- Both practitioner and manager are reticent to discuss what is not working and often brush the issues under the carpet until it is too late.
- Resentment grows and what is at stake—the patients, the practice and the staff—outweighs the actual issue, which is poorly managed expectations.

Info

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Of course, there are many practices managed by very capable staff members. However, for all the well-functioning practitioner–manager relationships, there are more people in these roles who prefer not to talk about the problems inherent within and who are only too glad for someone else to address the issues.

One of my aims is to facilitate management teams to assess where they are at present, to plan for appropriate change and to implement that change. The outcome is that a weight is lifted from your shoulders and focus moves to a united partnership working towards the success of the practice. In order to move forward, however, you must recognise where you are now.

An alternative approach

The first step towards achieving a successful management partnership is to honestly appraise your current situation. If anything I have said so far has touched a nerve, if frustration exists between you and the manager, or if you simply think things could be better, then acknowledge the fact and take action. Knowing what action to take for the best is probably the most difficult thing to assess.

The following are tips on getting started: Vocalize your vision, agree that your vision is realistic and share it with your team. Create a job description with and a training plan for your manager, as well as identify skills gaps and create smart objectives with and for her or him. Also agree and schedule regular one-to-one meetings and plan to assess and review with your manager. Most importantly, however, keep communicating.

Drive your success

Expectations always exist, even if we do not know what they are and despite them often being unrealistic. Managers have expectations of their roles and their employers have expectations of the person given responsibility for managing the practice. The problem is that mismatched expectations can lead to misunderstanding, frayed nerves and ruffled feathers. More seriously, they often lead to flawed systems, failed projects and a drain on resources.

There is nothing wrong with having expectations; the trick is to communicate them and to agree how they might be satisfied over time and with the right support. Managed expectations drive your success._

about

Lina Craven is founder and Director of Dynamic Perceptions, an orthodontic management consultancy and training firm in Stone in Staffordshire, and has many years of practice-based experience. She can be contacted at info@linacraven.com
Use and abuse of antibiotics

Author: Dr Steven G. Morrow, USA

Introduction

For the past 80 years, antibiotic therapy has played a major role in the treatment of bacterial infectious diseases. Since the discovery of penicillin in 1928 by Fleming and sulfanilamide in 1934 by Domagk, the entire world has benefited from one of the greatest medical advancements in history. The discovery of safe, systemic antibiotics has been a major factor in the control of infectious diseases and, as such, has increased life expectancy and the quality of life for millions of people.

According to the Centers for Disease Control and Prevention, life expectancy of individuals in the United States born in 1900 was 47 years, while those born in 2005 is projected to be 78 years. At the beginning of the 20th century, the infant (< 1 year) mortality rate in the United States was 100/1,000 live births compared to 6.7/1,000 in 2006. The major reason for these phenomenal achievements has been the ability to control infectious diseases.

Development of antibacterial drug resistance

Along with the dramatic benefits of systemic antibiotics, there has also been an explosion in the number of bacteria that have become resistant to a variety of these drugs. The problem is not the antibiotics themselves. They remain one of medicine’s most potent weapons against diseases. Instead, the problem is in the way the drugs are used. The inappropriate overuse of antibiotics has resulted in a crisis situation due to bacterial mutations developing resistant strains.

Many worldwide strains of Staphylococcus aureus exhibit resistance to all medically important antibacterial drugs, including vancomycin; and methicillin resistant S. aureus has become one of the most frequent nosocomial, or hospital-acquired, pathogens. The rate at which bacteria develop resistance to antibacterial drugs is alarming, demonstrating resistance soon after new drugs have been introduced. This rapid development of resistance has contributed significantly to the morbidity and mortality of infectious diseases, especially nosocomial infections.

A nosocomial infection is a hospital-acquired infection that develops in a patient after admission. It is usually defined as an infection that is identified at least 48 to 72 hours following admission, so infections incubating, but not clinically apparent at admission, are excluded. Nosocomial infections are costly, resulting in increased morbidity, requiring longer periods of hospitalization and limiting access of other patients to hospital resources. The direct costs of hospital-acquired infections in the United States are estimated to be $4.5 billion per year. Nosocomial infections also contribute to the emergence and dissemination of antimicrobial-resistant organisms. Antimicrobial use for treatment or prevention of infections facilitates the emergence of more resistant organisms. Patients with infections caused by antimicrobial-resistant organisms are then a source of infection for hospital staff and other hospitalized patients. These drug-resistant infections may subsequently spread to the community.

The British Society for Antimicrobial Chemotherapy published a review in the Journal of Antimicrobial Chemotherapy. This review examined the contributions antibiotic prescribing by general dentists in the United Kingdom has made to the selection of antibiotic resistance in bacteria of the oral flora. The review concluded that inappropriate antibacterial drug prescribing by dental practitioners is a significant contributing factor in the selection of drug-resistant bacterial strains.

The American Dental Association reported the results of a survey of antibiotic use in dentistry in the November 2000 Journal of the American Dental Association. The authors surveyed all licensed dentists practicing in Canada and found that confusion about prescribing antibiotics and inappropriate prescribing practices were evident, and that inappropriate antibiotic use, such as improper dosing, duration of therapy and prophylaxis are all factors that may affect development of antibiotic resistant microorganisms.

There is a glimmer of hope

A report from Aker University in Oslo, Norway, strongly suggests that bacterial resistance to antibacterial agents can be reversed. While dangerous
and contagious staph infections kill thousands of patients in the most sophisticated hospitals in Europe, North America and Asia, there is virtually no sign of this “killer superbug” in Norway. The reason? Norway stopped using so many antibiotics.

“We don’t throw antibiotics at every person with a fever. We tell them to hang on, wait and see, and we give them a Tylenol to feel better,” said Dr John Haug, infectious disease specialist at Aker University Hospital. In Norway’s simple solution, there is a glimmer of hope.

The proper clinical use of antibacterial drugs

In 1997, the ADA Council on Scientific Affairs issued a position statement on Antibiotic Use in Dentistry. The Council stated: “Microbial resistance to antibiotics is increasing at an alarming rate. The major cause of this public health problem is the use of antibiotics in an inappropriate manner, leading to the selection of dominance of resistant microorganisms and/or the increased transfer of resistance genes from antibiotic-resistant to antibiotic-susceptible microorganisms.”

The council’s position statement further identified that “Antibiotics are properly employed only for the management of active infectious disease or the prevention of metastatic infection, such as infective endocarditis, in medically high-risk patients.”

One method of education is to teach from errors rather than principles. Psychologists from the University of Exeter have identified an “early warning signal” in the brain that helps us avoid repeating previous mistakes. Published in the Journal of Cognitive Neuroscience, their research identifies for the first time, a mechanism in the brain that reacts, in just one-tenth of a second, to things that have resulted in us making errors in the past. Evaluating the following eight misconceptions or “myths” may help to establish general guidelines to aid us in making clinical decisions regarding the use of antibiotic therapy, thereby leading to optimum use and therapeutic success.

Myth No. 1: Antibiotics cure patients

Except in patients with a compromised immune system, antibiotics are not curative, but instead function to assist in the re-establishment of the proper balance between the host’s defenses (immune and inflammatory) and the invasive agent(s). Antibiotics do not cure patients; patients cure themselves.

Myth No. 2:
Antibiotics are substitutes for surgical intervention

Very seldom are antibiotics an appropriate substitute for removal of the source of the infection (extraction, endodontic treatment, incision and drainage, periodontal scaling and root planning). Occasionally, when the infection is too diffuse or disseminated to identify a nidus for incision, or the clinical situation does not allow for immediate curative treatment, the prudent dentist will choose to place the patient on appropriate antibacterial therapy until such time as curative treatment can be implemented. It is imperative to remove the cause of the infection prior to, or concomitant with, antibiotic therapy, when the cause is readily identifiable. Whenever antibiotic therapy is used, the risk of bacterial selection for antibiotic resistance is present.

Myth No. 3: The most important decision is which antibiotic to use

To avoid the deleterious effects of needless antibiotics on patients and the environment, the most important initial decision is not which antibiotic to prescribe but whether to use one at all. It has been estimated that up to 60 percent of human infections resolve by host defenses alone following removal of the cause of the infection without antibiotic intervention.
Endodontic disease is infectious. Microorganisms cause virtually all pathoses of the pulp and periradicular tissues. There is ample evidence to support that opportunistic normal oral microbiota colonize in a symbiotic relationship with the host, resulting in endodontic infections. The majority of endodontic infections do not require systemic antibiotic therapy when the cause of the infection has been properly managed (complete debridement of the pulp space and proper obturation and sealing of the pulp space from the oral environment).

Apical periodontitis lesions of pulpal origin are generated by the immune system and are the result of intra radicular infections (Fig. 1). In most situations, this inflammatory process successfully eliminates the bacteria emerging from the apical foramen and prevents their spread to the periradicular tissues. This process is primarily facilitated by the polymorphonuclear leukocytes that eventually phagocytize and kill the bacteria. Asymptomatic apical periodontitis of pulpal origin does not routinely require systemic antibiotic therapy for satisfactory resolution and healing. Endodontic therapy alone is usually sufficient.

When the intra radicular infection is able to overwhelm the host’s immune response, viable bacteria are able to gain access to the periradicular tissues and colonize, forming an active infection. This results in the formation of an apical abscess. A chronic apical abscess usually presents with gradual onset, no to mild symptoms and the presence of a sinus tract or parulis (Fig. 2). The majority of chronic apical abscesses of endodontic origin do not require systemic antibiotic therapy for satisfactory resolution and healing.

An acute apical abscess usually presents with rapid onset, spontaneous pain and swelling, both localized and intraoral, sometimes with exudate present, or with diffuse facial cellulitis. When the abscess is intraoral and localized (Fig. 3), debridement of the pulp space and placement of calcium hydroxide and surgical incision for drainage is usually sufficient to resolve the problem. Systemic antibiotic therapy is not routinely indicated, depending on the patient’s general medical status. However, when the patient presents with diffuse facial swelling (cellulitis) resulting from an acute apical abscess or an infection with systemic involvement (fever or malaise) (Fig. 4), debridement of the pulps pace with placement of calcium hydroxide, surgical incision for drainage, when possible, and an appropriate regimen of systemic antibiotics (oral or IV) are the treatments of choice.

Understanding the enemy is an important factor in winning any battle. The rational choice and use of antimicrobial agents begins with the knowledge of the microorganisms most likely responsible for common dental infections of pulpal origin. The bacterial flora found in endodontic infections is indigenous, mixed (Gram-positive and Gram-negative) and predominately anaerobic. Several species have been implicated with acute apical abscesses. These species include dark-pigmented bacteria (Prevotella and Porphyromonas), eubacteria, fusobacteria and Actinomyces.

Baumgartner and Xia published a report of the susceptibility of bacteria recovered from acute apical abscesses to five commonly used antibiotics in dentistry. Antibiotic susceptibility data from 98 species of bacteria recovered from 12 acute apical abscesses led to the following conclusions:

1. Pen-V-K is the antibiotic of choice for endodontic infections due to its effectiveness in polymicrobial infections, its relative narrow spectrum of activity against bacteria most commonly found in endodontic infections, its low toxicity and low cost.
2. Clindamycin is the antibiotic of choice for patients allergic to penicillins.
3. While amoxicillin and augmentin (amoxicillin plus clavulenate) demonstrated a higher antibacterial effectiveness than Pen-V-K, due to the broader antibacterial spectrum of amoxicillin and the increased cost of augmentin, the authors recommended that amoxicillin/augmentin be reserved for unresolved infections and patients who are immunocompromised.
4. Metronidazol demonstrated the greatest amount of bacterial resistance and is only effective against anaerobes. Therefore, it should not be used alone for the treatment of endodontic infections.14

Myth No. 4: Antibiotics increase the host’s defense to infection

The increased prevalence in organ and tissue transplants, resulting in patients with compromised immune systems, has heightened the interest in the potential effects of antimicrobial drugs on the host’s resistance to infection.15 In vivo and in vitro studies are highly variable and sometimes contradictory. However, the following considerations appear valid: 1) Antibiotics that can penetrate into the mammalian cell (erythromycin, tetracycline, clindamycin and metronidazole) are more likely to affect the host defenses than those that cannot (beta-lactams); 2) Tetracyclines may suppress white cell chemotaxis; 3) Most-antibiotics (except tetracycline) do not depress phagocytosis; and 4) T- and B-lymphocyte transformation may be depressed by tetracyclines. The greatest potential harm to the host defenses may result from antibiotics that easily penetrate into the mammalian cell and the least harm is observed with bactericidal, non-penetrating agents (penicillins and cephalosporins).

Myth No. 5: Multiple antibiotics are superior to a single antibiotic

It is often assumed that a combination of antibiotics is superior to a single carefully chosen antibacterial agent. When the purported benefits of antibiotic combinations are weighed against the possible consequences to the host as well as to the bacterial environment, this assumption is not always reality. The usual sequelae to combined antibiotic therapy results in a greater selective pressure on the microbial population to develop drug resistance. The greater the antibacterial spectrum of the antimicrobials used, the greater the number of drug-resistant microorganisms that develop, and the more difficult it is to treat a resulting superinfection. The primary clinical indication for combined antimicrobial therapy is a severe infection in which the offending organism(s) is unknown and major consequences may ensue if antibiotic therapy is not instituted immediately before culture and sensitivity tests are available.3

Myth No. 6: Bactericidal agents are always superior to bacteriostatic agents

Bactericidal agents are required for patients with impaired host defenses.3 However, bacteriostatic agents are usually satisfactory when the host’s defenses against infections are unimpaired. Post-antibiotic effects (PAEs—persistent suppression of bacterial growth after previous exposure to antibiotics) are more persistent and reliable with bacteriostatic agents (erythromycin, clindamycin) than with bactericidal agents (beta-lactamase) because the clinical effects of bacteriostatic agents are less dose-dependent.

Myth No. 7: Antibiotic dosages, dosing intervals and duration of therapy are established for most infections

After more than 80 years of antibiotic usage, the proper dosages, dosing intervals and duration of therapy are essentially unknown for most specific infections.3 Infectious diseases are associated with a high number of variables that affect treatment outcome (microbial characteristics and drug sensitivity, diverse resistance mechanisms, tissue barriers to antibiotic diffusion, and the integrity and activity of the host’s defense mechanisms). However, basic principles are available to guide the dental health care provider in establishing proper dosages, dosing intervals and duration of therapy once the microbial pathogen(s) is suspected or identified and a rational choice of antimicrobial agent is made.

The following principles of antibiotic dosing are adapted from Dr Thomas J. Pallasch3:
1. The current recommendation is to employ an antimicrobial on an intensive basis with vigorous dosage for as short a period of time as the clinical situation permits. The major factor in the clinical success of most antimicrobial agents is the height of the serum concentration of the drug and the resulting amount in the infected tissue(s). Also im-

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**Primary Reasons for Revision of Infective Endocarditis Guidelines**

1. IE is much more likely to result from frequent exposure to random bacteremias associated with daily activities than from bacteremias caused by a dental, GI tract or GU tract procedure.

2. Prophylaxis may prevent an exceedingly small number of cases of IE, if any, in individuals who undergo a dental, GI tract or GU tract procedure.

3. The risk of antibiotic-associated adverse events exceeds the benefit, if any, from prophylactic antibiotic therapy.

4. Maintenance of optimal oral health and hygiene may reduce the incidence of bacteremia from daily activities and is more important than prophylactic antibiotics for a dental procedure to reduce the risk of IE.

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**Table 1**
Medical Conditions for Which Endocarditis Prophylaxis is Recommended:

Premedication is recommended ONLY for patients with the following conditions associated with the highest risk of adverse outcomes from endocarditis:

1. Prosthetic cardiac/heart valve.
2. History of IE.
3. Cardiac transplant recipients who develop valve pathology.
4. One of the following congenital heart diseases:
   - Unrepaired cyanotic CHD, including palliative shunts and conduits.
   - Completely repaired congenital heart defects with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first six months after placement of the material or device (because endothelialization of prosthetic material occurs within six months after the procedure).
   - Re-implanted CHD with residual defects at, or adjacent to, the site of a prosthetic patch or prosthetic device (which inhibits endothelialization).

5. Special situations and circumstances:
   - Patients already receiving antibiotics—Occasionally, a patient may be taking an antibiotic when coming for a dental appointment. If the patient is taking an antibiotic normally used for endocarditis prophylaxis, it is prudent to select a drug from a different class rather than increase the dose of the current antibiotic. If possible, you should delay the dental procedure until at least 10 days after completion of the antibiotic. This will allow for the usual oral flora to be re-established. If an individual receiving long-term parenteral antibiotic therapy for IE requires dental treatment, the treatment should be timed to occur 30 to 60 minutes after the parenteral antibiotic therapy has been delivered.
   - Failure to administer pretreatment antibiotic dose—If the dosage of an antibiotic is inadvertently not administered before the procedure, the dosage may be administered up to two hours after the procedure. However, administration of the dosage after the procedure should be considered only when the patient did not receive the preprocedure dose.
   - Individuals with kidney dialysis shunts—Individuals with permanent kidney dialysis shunts should be placed on prophylactic antibiotics using the same protocol as for IE.

Table 2

<table>
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<tr>
<th>Myth No. 8: Bacterial infections require a &quot;complete course&quot; of antibiotic therapy</th>
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<tr>
<td>There is no such thing as a &quot;complete course&quot; of antibiotic therapy. The only guide for determining the effectiveness of antibiotic therapy, and hence, the duration of treatment, is the clinical improvement of the patient. A common misconception asserts that prolonged (after clinical remission of the disease) antibiotic therapy is necessary to prevent &quot;rebound&quot; infections.</td>
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Antibiotics CE article

Some infections from occurring. Orofacial infections do not "rebound" if the source of the infection is properly eradicated. Most orofacial infections persist for two to seven days, and often less. Patients placed on antibiotic therapy for an orofacial infection should be clinically evaluated on a daily basis. When there is sufficient clinical evidence that the patient’s host defenses have regained control of the infection and that the infection is resolving or resolved, the antibiotic therapy should be terminated.

Antibiotic prophylaxis for medically at-risk patients

Antibiotic prophylaxis is the administration of antibiotics to patients without evidence of infection to prevent bacterial colonization and reduce subsequent postoperative or post-treatment complications. The only established use of antibiotic prophylaxis in dentistry is in the attempt to reduce the potential consequences of bacteremias induced by dental treatment in certain medically at-risk patients. The principle indication for antibiotic prophylaxis for dental patients is the prevention of infective endocarditis during specified dental treatment of patients who also have specific medical conditions. Controversial indications include dental patients with orthopedic prosthetic devices, indwelling catheters and impaired (immunosuppressed) host defenses.

Dental patients presenting for treatment with impaired host defenses (chemotherapy, organ transplant or tissue graft recipient, insulin-dependent diabetes, alcoholics) or patients with indwelling catheters (hemodialysis) may benefit from antibiotic prophylaxis if their white cell count is below 2,500 (normal = 4,000–11,000). It is not currently recommended that patients with AIDS receive routine antibiotic prophylaxis prior to dental treatment. The opportunistic pathogens common to this disorder are not susceptible to routine prophylactic antibiotics and such a practice may result in the development of antibiotic-resistant microorganisms, thereby resulting in a serious superinfection.

Antibiotic prophylaxis for prevention of infective endocarditis

The American Heart Association has published guidelines for the prevention of IE in medically at-risk patients for more than 50 years. The most recent guidelines, published in April 2007, represent a significant change from the previous guidelines. One of the stated reasons for the development of the current revised guidelines was that the risk of antibiotic-associated adverse events exceeds the benefit, if any, from prophylactic therapy (Table 1). It is well accepted that the risk for developing bacterial resistant strains to the antibiotic drug used is considered an antibiotic-associated adverse event.

The majority of published studies regarding IE being caused by oral bacteria have focused on dental procedures. Although the infective dose required to cause IE in humans is unknown, the number of microorganisms present in the blood following a dental procedure is low. It has long been assumed that dental procedures may cause IE in patients with underlying cardiac risk factors and that antibiotic prophylaxis is ineffective. However, scientific proofs lacking to support this assumption. Cases of IE caused by oral bacteria probably result more from exposures to low inocula of bacteria in the bloodstream that result from routine daily activities (brushing and flossing) and not from a dental procedure.17

The 2007 AHA report regarding prevention of IE concludes: “If prophylaxis is effective, such therapy should be restricted to those patients with the highest risk of adverse outcomes from IE and who would derive the greatest benefit from prevention. In patients with underlying cardiac conditions associated with the highest risk of adverse outcomes from IE, prophylaxis for some dental procedures is reasonable, even though we acknowledge that its effectiveness is unknown.”17

Therefore, the 2007 AHA guidelines suggest that antibiotic prophylaxis should be considered for patients presenting for treatment with the cardiac conditions identified in Table 2, and who are undergoing any dental procedure that involves the gingival tissues or periapical region of a tooth and for those procedures that perforate the oral mucosa. This would include procedures such as biopsies, suture removal, placement of orthodontic bands, and intraligamentary and intraosseous local anesthetic injections, but it does not include routine local anesthetic injections through non infected tissue (Table 3).

Dental Procedures for Which Antibiotic Prophylaxis is Reasonable

- Dental extractions
- Periodontal procedures, including surgery, subgingival placement of antibiotic fibers/strips, scaling and root planing, proving, recall maintenance
- Dental implant placement
- Replantation of avulsed teeth
- Endodontic (root canal) instrumentation only if beyond the root apex and endodontic surgery
- Initial placement of orthodontic bands (not brackets)
- Intraligamentary and intraosseous local anesthetic injections
- Postoperative suture removal (in selected circumstances that may create significant bleeding)
- Prophylactic cleaning of teeth or implants where bleeding is anticipated

Table 3
Antibiotic prophylaxis for prevention of delayed prosthetic joint infection

In 1997, the ADA and the American Academy of Orthopedic Surgeons convened an expert panel of dentists, orthopedic surgeons and infectious disease specialists and published an Advisory Statement on Antibiotic Prophylaxis for dental patients with prosthetic joints. A 2003 advisory statement included some modifications of the classification of patients at potential risk and the stratification of bacteremic dental procedures (Table 4), but no changes in terms of suggested antibiotics or antibiotic regimens. Antibiotic prophylaxis is not indicated for most dental patients with total joint replacements or for patients with pins, plates or screws. However, it is advised to consider antibiotic premedication in a small number of patients who may be at potential increased risk of experiencing hematogenous total joint infection (Table 5).

While bacteremias can cause hematogenous seeding of total joint implants, it is likely that more oral bacteremias are spontaneously induced by routine daily events than are dental treatment-induced. Patients who have undergone total joint arthroplasty should be encouraged to perform effective daily oral hygiene procedures in order to maintain good oral health. The risk of bacteremia is much higher in a mouth with chronic inflammation than one that is healthy and well maintained.

Occasionally, a patient with a total joint prosthesis may present for dental treatment with a recommendation from his or her physician that is inconsistent with the current guidelines. In this case, the dentist is encouraged to consult with the patient’s physician to discuss the nature of the needed dental treatment, to review the current guidelines regarding antibiotic prophylaxis and to determine if there are any special considerations that might affect the physician’s decision regarding antibiotic prophylaxis for the patient. After this consultation, the dentist may decide to follow the physician’s recommendation or, if in his or her professional judgment antibiotic prophylaxis is not indicated, decide to proceed with the needed dental treatment without antibiotic prophylaxis. The dentist is ultimately responsible for making treatment decisions for his or her patient based on the dentist’s professional judgment.

In February 2009, the AAOS published an information statement in which the organization, “recommends that clinicians consider antibiotic prophylaxis for all total joint replacement patients prior to any invasive procedure that may cause bacteremia.” In response to this statement, the American Academy of Oral Medicine published a position paper in the June 2010 edition of the Journal of the American Dental Association.

The authors of the AAOM position paper stated that they reviewed the available literature on the subject as it relates to the AAOS 2009 information statement and concluded: “The risk of patients’ experiencing drug reactions or drug-resistant bacterial infection and the cost of antibiotic medications alone do not justify the practice of using antibiotic prophylaxis in all patients with prosthetic joints.” The authors called for a future multidisciplinary, systematic review of the literature relating to antibiotic prophylaxis use in patients with prosthetic joints. In the meantime, they concluded that the new AAOS 2009 information statement should not replace the 2003 joint consensus statement.

In December 2012, a panel of experts representing the American Academy of Orthopedic Surgeons and the American Dental Association published a systematic review and clinical practice guideline, titled “Prevention of Orthopaedic Implant Infection in Patients Undergoing Dental Procedures: Evidence based Guideline and Evidence Report.” This report contained the following three recommendations:

- The practitioner might consider discontinuing the practice of routinely prescribing prophylactic antibiotics for patients with hip and knee prosthetic joint implants undergoing dental procedures.
- We are unable to recommend for or against the use of topical oral antimicrobials in patients with...
prosthetic joint implants or other orthopedic implants undergoing dental procedures.

“In the absence of reliable evidence linking poor oral health to prosthetic joint infections, it is the opinion of the work group that patients with prosthetic joint implants or other orthopedic implants maintain appropriate oral hygiene.”

The report also stated that the above recommendations “are not intended to stand alone. Treatment decisions should be made in light of all circumstances presented by the patient. Treatments and procedures applicable to the individual patient rely on mutual communication between patient, physician, dentist and other healthcare practitioners.”

In 2014, a panel of experts convened by the American Dental Association Council on Scientific Affairs developed an evidence-based clinical practice guideline on the use of prophylactic antibiotics in patients with prosthetic joints who are undergoing dental procedures. This clinical practice guideline was published in The Journal of the American Dental Association in January 2015 and contained the following recommendation:

“In general, for patients with prosthetic joint implants, prophylactic antibiotics are not recommended prior to dental procedures to prevent prosthetic joint infection. The practitioner and patient should consider possible clinical circumstances that may suggest the presence of a significant medical risk to providing dental care without antibiotic prophylaxis, as well as the known risks of frequent or widespread antibiotic use. As part of the evidence-based approach to care, this clinical recommendation should be integrated with the practitioner’s professional judgment and the patient’s needs and preferences.”

Summary

Since their discovery eight decades ago, safe systemic antibiotics have revolutionized the treatment of infections, transforming once deadly diseases into manageable health problems. However, the growing phenomenon of bacterial resistance, caused by the use and abuse of antibiotics and the simultaneous decline in research and development of new antimicrobial drugs, is now threatening to take us back to the pre-antibiotic era. Without effective treatment and prevention of bacterial infections, we also risk rolling back important achievements of modern medicine such as major surgery, organ transplantation and cancer chemotherapy.

Suggested Patient Type, Drug and Regimen for Antibiotic Prophylaxis for Total Prosthetic Joint Infection

<table>
<thead>
<tr>
<th>Patient Type</th>
<th>Drug</th>
<th>Regimen*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients not allergic to penicillin</td>
<td>Cephalexin, cephradine or amoxicillin</td>
<td>2 g orally 1 hour prior to dental procedure</td>
</tr>
<tr>
<td>Patients not allergic to penicillin and unable to take oral medication</td>
<td>Cefazolin or ampicillin</td>
<td>Cefazolin 1g or ampicillin 2 g IM or IV 1 hour prior to dental procedure</td>
</tr>
<tr>
<td>Patients allergic to penicillin</td>
<td>Clindamycin</td>
<td>600 mg orally 1 hour prior to dental procedure</td>
</tr>
<tr>
<td>Patients allergic to penicillin and unable to take oral medication</td>
<td>Clindamycin</td>
<td>600 mg IV 1 hour prior to dental procedure</td>
</tr>
</tbody>
</table>

*Note: No second doses are recommended for any of these dosing regimens.

A fundamentally changed view of antibiotics is needed. They must be looked on as a common good, where individuals must be aware that their choice to use an antibiotic will affect the possibility of effectively treating bacterial infections in other people. All antibiotic use, appropriate or not, "uses up" some of the effectiveness of that antibiotic, diminishing our ability to use it in the future. For current and future generations to have access to effective prevention and treatment of bacterial infections as part of their right to health, all of us need to act now. The window of opportunity is rapidly closing.


author

Dr Steven G. Morrow

Having taught future oral health-care professionals at Loma Linda University School of Dentistry since 1965, Steven Morrow, DDS, MS, is currently a professor in the department of endodontics that he chaired from 1987 to 1990. He maintains responsibilities he accepted in 2000 as director of patient care services and clinical quality assurance. He was director, District VI, of the American Association of Endodontists from 1990 to 1993. He has also served as president of the Southern California Academy of Endodontics and as president of the California State Association of Endodontists. In 1997, he earned diplomat status from the American Board of Endodontics. Since 1998, he has been a fellow of the American College of Dentists; and since 2003, he has served on the editorial review board of the Journal of Endodontics. A life member of the American Dental Association, the American Association of Endodontists and the California State Association of Endodontists, he is currently serving his second term as a member of the Dental Board of California.
Introduction

When treating dental trauma, the timeliness of care is key to saving the tooth in many cases. It is, therefore, important for all dentists to have an understanding of how to diagnose and treat the most common dental injuries. This is especially critical in the emergency phase of treatment.

Proper management of dental trauma is most often a team effort with general dentists, pediatric dentists or oral surgeons on the front line of the emergency service, and endodontic specialists joining the effort to preserve the tooth with respect to the pulp, pulpal space and root. An informed and coordinated effort from all team members ensures that the patient receives the most efficient and effective care.

Recently, a panel of expert members of the American Association of Endodontists prepared an updated version of Guidelines for the Treatment of Traumatic Dental Injuries.1, 2 These guidelines were based, in part, on the current recommendations of the International Association of Dental Traumatology (see www.iadtdentaltrauma.org for more information). This article provides an overview of the AAE guidelines; the complete guidelines are available for free download at www.aae.org/clinical-resources/trauama-resources.aspx.

The benefit of adhering to guidelines for treatment of dental trauma was recently shown in a study by Bucher et al.3 The study found that, compared with cases treated without compliance to guidelines, cases that adhered to guidelines produced more favorable outcomes, including significantly lower complication rates. The study also found that early follow-up visits were essential to ensure prompt treatment of complications when they arose.3

Emergency care

Prior to any treatment, one must evaluate the injury thoroughly by careful clinical and radiographic investigation. It is recommended to follow a check list to ensure that all necessary information regarding the patient and the injury is gathered, including:
1. Patient’s name, age, sex, address and contact numbers (include weight for young patients).
2. Central nervous system symptoms exhibited after the injury.
3. Patient’s general health.
4. When, where and how the injury occurred.
5. Treatment the patient received elsewhere.
6. History of previous dental injuries.
7. Disturbances in the bite.
8. Tooth reactions to thermal changes or sensitivity to sweet/sour.
9. If the teeth are sore to touch or during eating.
10. If the patient is experiencing spontaneous pain in the teeth.

Once all of this information is gathered, a diagnosis can be made and appropriate treatment rendered. If the injured individual is not a patient of record, all necessary demographic information should be gathered as soon as the patient arrives and prior to any assessment. In the case of avulsion and the tooth being out of

Fig. 1a: Clinical case of two uncomplicated crown fractures in which the two broken pieces were located and reattached. (Photos: Provided by American Association of Endodontists)

Figs. 1b & c: After the two pieces had been attached, a chamfer was cut along the fracture line and additional composite cured in place. This will both increase the strength of the attachment and better hide the fracture line.

Fig. 1a Fig. 1b Fig. 1c
its socket, one should immediately place the tooth in a physiological solution of specialized media (such as Hank’s Balanced Salt Solution) or milk, or saline if those are not available. Only after the tooth is secured in solution should one obtain the patient’s information. Once the patient is seated in the dental chair, it is necessary to do a quick central nervous system (CNS) evaluation before proceeding with further assessments.

Often, the dentist is the first health-care provider to see the patient after a head injury (any dental trauma is, by definition, a head injury) and must assess the risk of concussion or hemorrhage. It has been estimated by a meta-analysis that the prevalence of intracranial hemorrhage after a mild head injury is 8 percent, and the onset of symptoms can be delayed for minutes to hours. The most common signs of serious cerebral concussion or hemorrhage are loss of consciousness or post-traumatic amnesia. Nausea/vomiting, fluids from the ear/nose, situational confusion, blurred vision or uneven pupils, and difficulty of speech and/or slurred speech may also indicate serious injury.

Once the patient has been cleared of any CNS issues, the dental trauma should be assessed. The key is to obtain comprehensive information about the injury and, to do so, one must conduct thorough extra-oral and intraoral clinical exams as well as appropriate radiographic evaluations.

The new AAE guidelines recommend taking one occlusal and two periapical radiographs with different lateral angulations for all dental injuries, including crown fractures. If cone-beam computed tomography is available, it should be considered for more serious injuries, such as crown/root, root and alveolar fractures, as well as all luxation injuries.

Additionally, sensibility tests should be conducted on all teeth involved as well as opposing teeth. Cold testing is recommended over electric pulp testing in young individuals. Both testing methods should be considered, however, especially when there is no response to one of the two. The pulp might be non-responsive for several weeks after a traumatic injury, so a pulp test should be done at every follow-up appointment until a normal response is obtained.

Once the diagnosis is confirmed and more serious complications such as CNS and jaw or other facial bone fractures have been ruled out, the emergency phase of the treatment needs to be initiated. The aim of treating dental trauma should be to either maintain or regain pulpal vitality in traumatized teeth. This is because dental trauma most frequently occurs in pre-

![Fig. 2a](image)

**Fig. 2a:** Schematic diagram of minimal pulpotomy, where an approximately 2-mm reservoir is cut with a high-speed diamond bur and copious water cooling and calcium hydroxide mixed with sterile water placed. (Schematic drawings/Provided by Dr Sigurðsson)

**Fig. 2b:** Glass ionomer or a protective liner is placed over the pulp capping agent to ensure it stays in place during etching and bonding.

**Fig. 2c:** Clinical pictures of the minimal pulpotomy.
Follow-Up Procedures for Fractured Permanent Teeth and Alveolar Fractures

<table>
<thead>
<tr>
<th>TIME</th>
<th>Crown Fracture</th>
<th>Crown-Root Fracture</th>
<th>Root Fracture</th>
<th>Alveolar Fracture</th>
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<tbody>
<tr>
<td></td>
<td>Uncomplicated</td>
<td>Complicated</td>
<td>Uncomplicated</td>
<td>Complicated</td>
</tr>
<tr>
<td>4 Weeks</td>
<td></td>
<td></td>
<td>Splint removal*, clinical and radiographic control</td>
<td>Splint removal and clinical and radiographic controls</td>
</tr>
<tr>
<td>6–8 Weeks</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
</tr>
<tr>
<td>4 Months</td>
<td></td>
<td></td>
<td>Splint removal**, clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
</tr>
<tr>
<td>6 Months</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
</tr>
<tr>
<td>1 Year</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
</tr>
<tr>
<td>Yearly for 5 Years</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
<td>Clinical and radiographic control</td>
</tr>
</tbody>
</table>

*Splint removal in apical third and mid-root fractures; **Splint removal with a root fracture near the cervical area.

Fig. 3d: A periapical radiograph of a root fracture a few hours after the injury. It was established that both fragments were in good approximation of each other. Splinting was done for two weeks.

Fig. 3e: At the nine-month recall, internal root resorption was noted, but no defect in the PDL or adjacent bone, indicating a ‘normal’ healing process.

Fig. 3f: Five-year recall, no endodontic treatment was needed.

Crown fractures

The first thing to do in any crown or crown-root fracture is to look for the broken-off tooth fragment. With modern bonding technology it is possible to re-bond the fragment to the tooth, which is esthetically the best solution. Prior to retauching the tooth fragment, the remaining dental thickness immediately covering the pulp needs to be assessed radiographically and clinically. If there is at least 0.5 mm of the dentin remaining, there is no need to cover it with a protective liner. If it is estimated that the remaining dentin is less than 0.5 mm, it is advisable to cover the deepest part, closest to the pulp, with a cavity liner, and then dimple the fragment accordingly. If the tooth fragment was kept dry, it should be rehydrated in distilled water or saline for 30 minutes prior to reattachment. This process will increase its bonding strength.

Clinical examples

Dental trauma can be roughly divided into two groups: fractures and luxation injuries. The fractures are then further divided by type: crown, crown-root and root fractures. If the pulp is exposed to the oral environment, it is called a complicated fracture; if not exposed, it is called an uncomplicated fracture.

In a complicated fracture, the goal is to create a bacteria-tight seal to protect the pulp, after ensuring that the pulp wound is clean and all inflamed tissue removed. The two best capping materials available today are calcium hydroxide and mineral trioxide aggregate (MTA), but newer bioceramic materials are showing promise for this application. It is advisable to create a 1-2 mm reservoir into the pulp with a high-speed diamond bur and copious water cooling, place the capping material, and then either reattach the tooth fragment or restore the crown with a composite resin material.
Crown-root fractures
One of the more challenging types of fracture to treat is the crown-root fracture because the fracture margin has to be exposed around the tooth/crown to properly restore the tooth.

This can be accomplished by gingivectomy if the fracture line is in the sulcus. In more extreme cases, the tooth will have to be extruded with orthodontic forces or surgically repositioned. In the emergency session, if the pulp is exposed, it needs to be protected in the same fashion as complicated crown fractures. If the pulp is not exposed, all accessible exposed dentin areas should be covered for the patient’s comfort.

Pulpal survival for all these fracture types is generally good; however, endodontic treatment may be indicated later. Therefore, it is of utmost importance that a recall schedule is followed and that the teeth involved in the trauma are tested every time. Tables 1 & 2 outline the recommended recall rates for most common dental injuries. It is not uncommon for there to be no response to vitality tests for up to three months, and a lack of response to vitality tests does not always indicate that root canal treatment is needed—especially in young and immature teeth. Rather, it is advisable to look for at least one other sign of pulpal necrosis, such as vestibule swelling, periapical lesions and/or dramatic color change of the crown. If no signs exist, continue to monitor the patient at regular appointments every three months, for up to one year.

Root fractures
The pulp is affected in all root fractures. However, if the fragments are approximated soon after the fracture, there is a good chance that no endodontic treatment is necessary, just observation. With good approximation, it is likely that the pulp will revascularize across the fracture regardless of the age of the patient (Figs. 3a–f). A recent retrospective study included assessment of splinting type and time of root fracture. The study determined that, if the cervi-

Table 2

<table>
<thead>
<tr>
<th>TIME</th>
<th>Concussion/Subluxation</th>
<th>Extrusion</th>
<th>Lateral Luxation</th>
<th>Intrusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Weeks</td>
<td>Splint removal (if applied for subluxation)</td>
<td>Splint removal</td>
<td>Splint removal</td>
<td>Splint removal</td>
</tr>
<tr>
<td></td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
</tr>
<tr>
<td>4 Weeks</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Splint removal</td>
<td>Splint removal</td>
</tr>
<tr>
<td></td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
</tr>
<tr>
<td>6–8 Weeks</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
</tr>
<tr>
<td>6 Months</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
</tr>
<tr>
<td>1 Year</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
<td>Clinical and radiographic examination</td>
</tr>
<tr>
<td>2–5 Years</td>
<td>Yearly up to 5 years</td>
<td>Yearly up to 5 years</td>
<td>Yearly up to 5 years</td>
<td>Yearly up to 5 years</td>
</tr>
</tbody>
</table>

Fig. 4a: In lateral luxation injuries of maxillary teeth, the apex is frequently pushed through the cortical plate facially.

Figs. 4b & c: To reposition the tooth, it has to be released prior to moving the crown forward.
cal portion of the tooth is stable once the two pieces have been approximated, no splint or a flexible splint for two weeks produces the best treatment outcome. Longer splinting time is recommended only when the fracture is close to the cervical area.

Luxation injuries

All luxation injuries will cause some damage to the periodontal ligament and, in some cases, the pulp as well. The immediate treatment is to limit further damage to the PDL and allow for the best possible healing. As with all dental injuries, follow-up is essential. Late complications, such as internal or external root resorptions, are relatively frequent and require endodontic treatment, especially in more severe injuries. In many of these cases, referral to an endodontist is advisable.

When trauma has moved the tooth out of its normal position, it needs to be replaced gently as soon as possible. The only exceptions are cases of intrusion when it might not be possible or advisable to manipulate the tooth immediately. When an immature tooth is intruded up to 7 mm, it is recommended to wait three weeks and watch for signs of re-eruption. If no signs exist, one can initiate orthodontic repositioning. For intrusion of more than 7 mm, surgical or orthodontic repositioning should be performed within three weeks. In the case of an intruded tooth with a closed apex, there is a possibility of re-eruption if the tooth is slightly intruded (less than 3 mm) and the patient is younger than 17 years old. If the tooth is not moving after two to three weeks, however, orthodontic extrusion or extraction and reimplantation is recommended. If a tooth with a closed apex is intruded more than 3 mm, orthodontic or surgical repositioning should be performed within three weeks. The risk with all intrusions is that the intruded tooth may ankylose in the infraposition. Once that begins, the tooth may not be movable except possibly surgically. It is well to advise the patient and the parents/guardians that the long-term prognosis of an intruded tooth is unpredictable, as it is likely to eventually be lost due to ankylosis.

Splinting of a luxated tooth is recommended only for teeth that are still mobile after repositioning. In all types of trauma cases, a splint must allow for physiological movement. (See Figs. 4a–c & 5, and Table 3, regarding splinting time.)

When assessing luxation trauma, it is important to consider the maturity of the apex. If it is still open, there is a chance that the pulp will survive the trauma or revascularize, allowing the growth of the tooth to continue (Figs. 6a–c).

If the apex is closed, endodontic treatment is likely needed. It is advisable to follow the patient closely (Table 1) or refer him or her to an endodontist for further evaluation. Because of the injury to the PDL, rapid inflammatory root resorption can occur within days or a few weeks if the necrotic pulpal tissue becomes infected. For mature teeth diagnosed with necrotic pulps, placing calcium hydroxide for two to four weeks

<table>
<thead>
<tr>
<th>Type of Injury</th>
<th>Splinting Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subluxation</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Extrusive luxation</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Avulsion</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Lateral luxation</td>
<td>2 weeks</td>
</tr>
<tr>
<td>Intrusion</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Root fracture (middle 1/3)</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Alveolar fracture</td>
<td>4 weeks</td>
</tr>
<tr>
<td>Root fracture (cervical 1/3)</td>
<td>4 months</td>
</tr>
</tbody>
</table>

Table 3
prior to obturation is recommended; however, one should allow the PDL to heal for two weeks before placement [see treatment for avulsion, below]. Apexification or revascularization is recommended for teeth with open apices.24,25

It is important to remember that dental injuries do not always fall into one group or category, but often a combination of several categories. Injuries in multiple categories will impact the outcome. For example, it was recently demonstrated that the existence of a concurrent luxation injury with an uncomplicated crown fracture and complete root development are significant risk factors of pulp necrosis.26

Avulsion
The time outside of the socket for an avulsed tooth is the most critical of its survival. If the tooth is re-planted within 30 minutes, or alternatively kept in a physiological solution of specialized media or milk for a few hours, it has a fairly good prognosis.27,28 If the tooth has been dry for more than one hour, the periodontal ligament cannot be expected to survive and the tooth will likely become ankylosed (Fig. 7). Once reimplanted, most teeth need to be stabilized with a physiological splint for two weeks.29

If the avulsed tooth has an open apex and was re-implanted within the hour, there is a possibility that the pulp will revascularize. In this case, delaying endodontic treatment at the emergency stage is recommended. Endodontic treatment should be performed later only if signs of pulp necrosis, root resorption and/or arrested root development are confirmed.

In the case of a closed apex, revascularization is not expected. Therefore, endodontic treatment must be initiated two weeks after the tooth is reimplanted, and prior to removal of the splint. Treatment should not be initiated earlier because any further manipulation of the tooth prior to or immediately after reimplantation can cause further damage to the PDL. In addition, it has been shown that placing calcium hydroxide as an intracanal medicament immediately after reimplantation will promote inflammation that can lead to PDL damage.30 If the tooth had been kept dry longer than 60 minutes, performing root canal treatment prior to replantation is indicated.31

After the emergency situation has been managed and the tooth/teeth stabilized, the second phase begins, in which the pulp condition and likelihood of root resorption have to be carefully evaluated and the patient followed over a period of months, if not years. A follow-up timeline is essential to allow for intervention if signs of complications appear. In such cases, the expertise and training of endodontists become important. Diagnosing, preventing and treating any pulpal complications are an integral part of endodontic training as are performing pulp regenerative procedures and treating inflammatory root resorption (Figs. 8a & b).

Conclusion
Traumatic dental injuries present difficult challenges for both patients and their dentists. Current evidence allows the dental health care provider to manage situations that, in the past, often resulted in crippled dentition and unsightly appearance. Appropriate treatment can turn what at first glance looks like a hopeless situation into a very satisfactory outcome for patients. The endodontic specialist can play an important role in the team approach to treating patients with traumatic dental injuries.

Fig. 7: Anklylosis or replacement root resorption, in which the root structure is lost and replaced by bone. Note that no apparent PDL space is seen.

Fig. 8a: Inflammatory root resorption secondary to pulp necrosis and infection in the pulpal space after avulsion. If diagnosed in time, it is possible to arrest the root resorption and maintain the tooth. Extensive inflammatory root resorption on a tooth that was avulsed and reimplanted, but no further treatment done for six weeks.

Fig. 8b: Calcium hydroxide was placed in the tooth for three months. Apparent healing of the peri-root lesions and some reconstitution of a normal looking PDL.

A complete list of references is available from the publisher.

author

Dr Asgeir Sigurdsson, DDS, MS, was born and raised in Reykjavik, Iceland. He received a dental degree from University of Iceland, Faculty of Dentistry, in 1988. After one year in private practice in Iceland, he moved to Chapel Hill, NC. He graduated from University of North Carolina (UNC) at Chapel Hill in 1992 with a certificate in endodontics and a master of science with emphasis on neurobiology and pain perception. He was a full-time faculty member at UNC School of Dentistry from 1992 until 2004, first as an assistant professor and then associate professor with tenure beginning in 2000. He was appointed as the graduate program director of endodontics (specialty training) in 1997 and served in that position until 2004. From 2004 to 2012 he was in a private endodontic practice in Reykjavik, Iceland, and London, England. In September 2012 he became the chairman of the department of endodontics at New York University College of Dentistry. Additionally, he holds the following academic positions: From 2004 adjunct associate professor at UNC; honorary clinical teacher in endodontology, UCL Eastman Dental Institute, London, from 2006; and from 2011 honorary clinical associate professor in the Faculty of Dentistry, the University of Hong Kong. He has lectured extensively around the world on dental trauma, endodontics, pain diagnosis and forensic dentistry. He is active in many professional organizations and is past president of the International Association for Dental Traumatology (IADT). He received the Edward M. Osetek Educator Award from the American Association of Endodontists in 1998.

Fig. 7: Anklylosis or replacement root resorption, in which the root structure is lost and replaced by bone. Note that no apparent PDL space is seen.

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Fig. 8b: Calcium hydroxide was placed in the tooth for three months. Apparent healing of the peri-root lesions and some reconstitution of a normal looking PDL.
Errors accumulate during procedures. That’s the reason botching the access at the start of an RCT is so much more devastating than say, problems that come from misfitting a gutta-percha cone just before finishing the case. Miss a canal and the case is going down, regardless of how brilliant the remaining procedure is carried out. Perforate the tooth, and suddenly titanium starts looking better. Cut huge access cavities, and expect to see relatively huge numbers of root-fractured teeth within five years of treatment. Simply cheat the access procedure by beginning the instrumentation of canals before a straight, perfectly smooth path has been cut to each canal orifice, and be punished every time a file, an irrigating needle, an explorer, a gutta-percha point, a paper point or a plugger is taken into each of the canals scores of times.

This is not a critique so much as an admission of the ways that teeth and their root canal systems have taught me, usually the hard way, to spend whatever time is needed to create perfect entry paths into canals, before I attempt to work in them. So why do I have to have a talk with myself before beginning every access cavity—even after doing this for 35 years—to be certain to hit the mark I know must be met before it is safe to venture further?

Zen and the art of endo access

Robert Persig, in his book “Zen and the Art of Motorcycle Maintenance,” described being deeply frustrated when a bolt stripped as he was attempting to remove the side covers to the engine of his motorcycle, before rebuilding it. The rebuild could not continue until he was able to circumvent this problem. He had expected to spend several days completing the mission, yet he was amazed at the fury he experienced when faced with this conundrum.

The more he thought about it, the more mystified he became about his instinctual response, until he realized that he was tweak because he had grossly undervalued this part of the long rebuild procedure, thinking mostly about the more dramatic routines to follow, such as cracking the cylinder case, honing the cylinder, replacing the piston and putting it all back together afterward. When he realized that nothing was going to progress until he had successfully removed the side cover, he made removing that side cover a separate and important mission, an accomplishment that would deliver satisfaction in and of itself, if it could be completed during the next several hours spent.
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So it is with endodontics. When we realize how critical the quality of our access preparations is to the remainder of the case, it feels like fingernails on a chalkboard to head into a canal before securing an ideal path into it. Aristotle got it right—excellence is a habit, not a character trait. So what do the habits of access excellence look like in this 21st century?

Failing to plan is planning to fail

Atul Gawande, in his book “The Checklist Manifesto,” describes the importance of planning not just which procedure to do, but how every single aspect of that procedure must be planned in detail, from start to finish, if consistently ideal results are the goal. Does the preoperative imaging accurately describe the anatomical challenges? Does the clinician have adequate magnification and light? Are the cutting tools adequate and well chosen? Are the locations, angles and depths of entry determined before beginning the procedure? Have maximal safe cutting lengths been marked on access burs? Are there procedures in place to deal with calcified canals that defy location? And so on.

In other words, the Alfred E. Neumann attitude of “What, me worry?” is not appropriate during this critical event. Conversely, when each of these critical elements is included in the treatment planning and execution of an ideal access cavity preparation, the rest of the procedure becomes progressively simpler as the finish is approached.

Radiographic imaging

We wouldn’t even attempt RCT without Roentgen’s invention of the dental radiograph, so it is not much of a stretch to claim the critical necessity of ideal preoperative radiography. Ideal preoperative X-ray imaging must include a straight-on angle that splits the mesial and distal contacts perfectly—taken either as a periapical or as a bitewing X-ray image, then at least one ideal off-angle view in order to capture data from the Z-plane (buccolingual) of the tooth in question.

In my practice, a mesial off-angle view of anteriors and premolars works well, because it is much easier to capture than a distal angle, and in anteriors and premolars the mesial view reveals as much radicular anatomy as a distal view. In molars it is different. In molars a distal view is far preferable to a mesial off-angle view, as the mesial view superimposes the body of the root over the distally curved root structure, while the distal view casts the apical root end sideways, where it can be more easily seen on the radiographic image.

Of course, cone-beam CT (CBCT) imaging is the unfair endodontic imaging advantage. If told I could have either a microscope or a CT machine, but not both, I would choose 3-D imaging every time. Only CBCT imaging can capture the mesial view of root structure—the view in which we see “The Secret Life of Root Canals”—the bucco-lingual plane containing the greatest degree of anatomic complexity. One of the greatest joys of having a CT machine in practice is knowing, for sure, before the access procedure is begun, that there is only a single canal in the mesiobuccal root of an upper molar. Conversely, one of the few negative experiences to be had with this technology is when the reconstructed volume shows two or three canals, in a root that has given up only one to the clinician’s exhaustive search.
The first gift of CBCT imaging to the field of endodontics has been the gift of finding all canals in a given tooth. Its second gift is the great diminution of access size possible, because the access cavity is no longer the primary viewing port into the pulp chamber and beyond. In fact, CT imaging is the only view needed into the anatomic verities of root canal spaces, allowing access cavities to be used exclusively as treatment, rather than as exploratory portals. Ultimately, RCT access procedures will be done with CT-generated drill guides, allowing molars to be treated through three to four 1-mm pea-holes, rather than the 2- to 4-mm access cavities used today.3

Outline form

So what are the objectives we consider when planning the invasion of a root canal space? Basically, all the best access cavities are cut in a balance between conservation and convenience form. We cut as little tooth structure as possible, while ensuring ideal pathways into each canal. Access outline form objectives become fairly simple then; we demand convenience form, otherwise we cannot complete our task, yet we always strive to preserve the structural integrity of the tooth. This boils down to three easily remembered objectives:

1) In anteriors and premolars, conservation form is found in the mesial-to-distal dimension. Traditionally, anterior access cavity outline form has been triangular because of the mesial and distal pulp horns in these teeth—logical until we consider the structural consequences, a needless weakening of coronal tooth structure to insure these pulp horns are cleaned out, when the smallest undercut with a #2 Mueller Bur or Buc-1 ultrasonic tip (Spartan) could suffice as well. Premolars have pulp chambers like the shape of a hand, which is fortunately arranged in a bucco-lingual direction, the angle of the recommended slot-like access cavity outline form is buccal-lingual as well, simultaneously combining convenience and conservation form.

In anterior teeth, convenience form is harder won as the incisal edge is to be avoided, out of respect for postendodontic aesthetic objectives, thus requiring a deeper cut under the cingulum, to allow a more straight-line entry path, while minding the “no-fly zone” of the incisal edge. The most dangerous anterior access cavity error is not cutting adequately through what Dr Schilder called the “lingual dentinal triangle” under the cingulum, and this can be accomplished with minimal structural weakening when the mesio-distal dimension is kept to a 1 to 1.5 mm width (Fig. 1).

2) In posterior teeth, premolars and molars, it is important to remember that their occlusal surfaces are not centred over the root structure, but are skewed toward the idling cusp side of the root structure. As pulp chambers are centred in the root structure, not centred under the occlusal surface, access in posterior teeth is best accomplished by cutting near working cusps, while staying 1–2 mm away from idling cusps (Fig. 2).

3) In molars, conservation form is held by avoiding the distal half of the occlusal plane, as ideal file paths from the distal canals of upper and lower molars are canted severely to the mesial, so much so that distal canals of lower molars are best referenced to the MB or ML cusp tips, and distobuccal canals of upper molars are best referenced to the palatal cusp tips. Convenience form is achieved by cutting the mesial wall of molar access cavities parallel to the mesial surface of the tooth (Fig. 3).

Back from the abyss

I was taught Schilder technique at University of the Pacific by Dr Michael Scianamblo and after grad school by Dr Cliff Ruddle. I understood the clinical imperative Dr Schilder had placed on cutting an access adequate to treat the entire root canal system in a predictable manner, and I enjoyed working through the large access cavities and the generous coronal canal shapes he recommended until I was brought up short by Dr Carl Reider, a well-known prosthodontic lecturer from Southern California.

When I asked what he most wanted from the endodontists he referred his patients to, he said he wished...
we could “just suck the pulp out, without cutting any tooth structure.” As we talked, I came to better understand the structural imperative of saving teeth in the long term, setting me on a quest for tools and methods that would allow us to achieve the same consistently ideal endodontic outcomes, through smaller access openings and coronal canal shapes.

Ultimately, it was the inspiration for my invention of the Maximum Flute Diameter (MFD) limitations on GT and GTX rotary files (DENTSPLY Tulsa Dental Specialties), the LAX (line angle extension) GuidedAccess Diamond Burs by SybronEndo, as well as obturation methods using flexible condensation devices, such as System-B Continuous Wave electric heat pluggers (SybronEndo) and GT/GTX Obturators (DENTSPLY Tulsa Dental Specialties).

The Itty Bitty Access Committee

Since that initial awakening in the ’80s, it has felt like being a lone voice in the wilderness until the past 10 years, when a new generation of dentists and endodontists, steeped in the new reality of implant dentistry as an alternative to RCT, have taken up the cry for longer-term outcomes through improved structural preservation, ultimately becoming what I jokingly call The Itty Bitty Access Committee (IABC).

As so often happens, somebody outside of our specialty, a general dentist named Dr David Clark, started lecturing on the access elephant in the endodontic living room. He got my buddy Dr John Khademi turned on to the possibilities that more conservative access cavities could offer the specialty, and one by one a group of young endodontists joined the game of who can do a perfect RCT through the smallest access cavity. This ad hoc group of talent began the IBAC club.

The cases shown in Figures 4 through 10—mostly done by IBAC members—make me very happy and afraid at the same time. What the heck are they doing? Little, tiny entries, leaving pulp chamber roofs intact, lateral pulp horns unroofed as well, or just total RCT through previously cut restorative cavities!

After getting over my initial shock at what they were accomplishing, I came to understand that the future of endo is very good in these extremely talented hands, and I saw that the procedure I was developing for endodontic surgery—CT-guided endodontic surgery (CT-GES)—could be applied to conventional treatment as well (Figs. 11a–12d).

And morning breaks over the field of endodontics._

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**Author**

Dr L. Stephen Buchanan, DDS, FACD, FICD, is a diplomate of the American Board of Endodontics, a fellow of the American and International Colleges of Dentists and serves as part-time faculty to the UCLA and USC graduate endodontic programs. He holds patents on the Endobender Plier (SybronEndo), System-B and Continuous Wave obturation tools and methods (SybronEndo), GT and GTX file systems (DENTSPLY Tulsa Dental Specialties), LA Axxess Burs (SybronEndo), and Buc ultrasonic tips (Spartan/Obtura). Buchanan lives in Santa Barbara, CA, where he enjoys a practice limited to conventional and microsurgical endodontics and dental implant surgery. He is the founder of Dental Education Laboratories, a hands-on training facility in Santa Barbara that he has directed for 28 years.
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Stairs to the Apex

Author: Dr Christophe Verbanck, Belgium

Sometimes endodontic specialists have to go the extra mile to save teeth. Only with the proper endodontic instruments success can be ensured in the most challenging situations. This case shows how the aid of HyFlex CM-files can help to deal with multiple iatrogenic deformations after several previous temporary root canal therapies. The use of these pre-bendable NiTi-files help us to get the root canal preparation “back on track”.

Endodontic intervention after a previous temporary treatment can sometimes pose a real challenge even for the most skilled endodontist. Some patients have a long history of unsuccessful root canal treatments. In a situation like this it becomes quite difficult to shape the canal when the natural path of the root canal is almost completely lost. The loss of dentin is often considerable after several dentists have literally tried to “push their luck”.

Iatrogenic damage

An 18-year old male patient presented with a painful lower right first molar. After thorough examination, both clinical and radiographic, tooth #46 was diagnosed to be the cause of his pain. On the pre-operative radiograph a (symptomatic) apical periodontitis could be recognized together with a leaky temporary restoration with decay underneath. Two mesial and a distal canal were filled with calcium hydroxide. Looking even more into detail a step could be observed in the distal root canal. Clinical the tooth was painful on percussion and biting forces, there was no reaction to cold or warmth and no pockets could be probed although the gum was inflamed due to the temporary restoration and decay that was left behind.

After further examination the patient explained the tooth had been treated in the recent past by no less than three different dentists. Recurring pain had forced him to seek treatment time and again after each provisional non-surgical root canal treatment (nsRCT). Apparently, each colleague had tried to work his or her way around the imperfect preparation of their predecessors leading to a root canal with the shape of a staircase. The absence of a good coronal seal lead to improper healing and thus caused a chain reaction of re-interventions which resulted in iatrogenic damage of the root canal walls.

Re-shaping the root canal preparation

After applying a dental dam the first step was to remove the temporary filling and decay, the pulp floor was checked for perforations and all orifices were located. The canals were then scouted, patency was regained and with small hand files (K-flexofiles ISO 06 up to ISO 20) a manual glide path was established in all four root canals. After scouting it was clear that several steps, luckily without any perforation, were...
present in the distal and in the mesio-buccal canals. In a case like this it is important to redefine the shape of the previous preparation and first and foremost an endodontic file system is needed that is flexible and prevents further unproportional loss of tooth substance.

For the canal preparation a renowned nickel titanium file system by Swiss dental specialist COLTENE (Fig. 2) was used. Thanks to a clever combination of unique material properties, pre-bendable HyFlex CM files are virtually unbreakable. The reason for this phenomenon is simple: the well-known "Controlled Memory"-effect is flexible enough to find its way around the distorted canals. It improves certain physical qualities of the alloy itself. Similar to classical stainless steel files the instruments can be pre-bent, but they do not bounce back like conventional NiTi files. This typical characteristic makes "CM"-treated NiTi files extremely flexible. Highly versatile files are particularly helpful if you have to move around abrupt curves or—in this case—a mutilated anatomy. After usage their form adaptation can be quickly reversed in the sterilization process. During autoclaving the instruments turn back to their original shape (Fig. 3). The refined NiTi files are very resistant to cyclic fatigue and can be reused safely, as long as they are not plastically deformed.

The Hyflex CM-files respond to excessive resistance with straightening of the spirals, which avoids binding to the walls. To create any form of steps in the canal shape is incredibly hard and instrument separation is almost impossible, as long as the files are applied correctly. A good preparation technique is to move the file in a soft pecking motion through the canal. In addition to that it is highly advisable to irrigate the canal thoroughly every time a file in the sequence is changed.

Once the manual glide path was created, it was very easy to bypass the various steps and ledges with the pre-bendable HyFlex files (Fig. 4). The mechanical rotation was started on the endodontic motor only after the insertion of the pre-bent instrument in the canal beyond the step. By this approach the risk of perforation is generally eliminated and no further damage of the root canal wall takes place at the level of the step. Beyond the step we used the rotating files as usual at the normal operating mode of 500 rpm. With only a few files per canal it was possible to instrument the root canal up to a working length of 21 mm. The mesio-lingual canal was finally instrumented with a pre-bent .35/0.06 file (Fig. 5). The file was inserted into the canal with two to three subtle movements, then withdrawn before it re-entered the canal. Similarly, the mesio-buccal canal was shaped with a size .35 file with a taper of 0.04 (Fig. 6). To enlarge the apical aspect of both the disto-lingual and the disto-buccal canal a 45/0.04 file was used (Fig. 7).

All files kept their pre-bent shape during the procedure and moved safely in the centre of the canal. Even unexpected angles could be managed almost effortlessly with the swift moving instruments. Despite the numerous steps that got sculptured into the root canal before a smooth shape was finally regained, which would ensure a tight and reliable obturation of the root canal system (Fig. 8).
Successfully preventing re-infection

As mentioned above, a thorough rinsing protocol was performed throughout the whole nsRCT. The constant copious irrigation helped to clear the canal of remaining debris or necrotic tissue. As cleaning irrigants we used sodium hypochlorite (NaOCl) in a concentration of 5.25% and citric acid (40%). Both irrigants were activated by ultrasound as well as manual dynamic activation (cone pumping). Corresponding paper points were inserted to dry the canals afterwards.

In the end a bioceramic sealer and gutta percha were used in the hydraulic condensation technique for permanent obturation (Fig. 9). After curing, bioactive filling material can form so-called hydroxyapatite crystals on the surface. The crystals help to stimulate the regeneration of bone and dentin tissue in
particular. The coronal restoration was topped off with a composite and a core build-up of glass fibre reinforced composite. Further indirect restoration is planned to be done by the referring dentist.

The post-operative X-rays illustrate two interesting aspects (Figs. 10 & 11): first of all, the obturating material was safe in place and together with the tight seal of the coronal restoration should keep another reinfection at bay. Secondly, the steps were still visible. Especially the mesio-buccal and distal canals looked imposing in relation to their normal size. However, the composition as a whole appeared to be stable with enough dentine surrounding the apex. We were able to save the tooth and the patient left our endodontic practice with an uplifting prognosis despite his unfortunate entry.

Experts for root canal treatment

In our line of work, we often witness patients that dread visiting an endodontic specialist. This sometimes leads to a situation were the general practitioner tries to perform a complex nsRCT himself turning it in an even more complex treatment. Of course, the enormous technical progress in endodontic instruments helps dentists to work professionally and confidently—almost irrespective of their level of experience. Modern endo equipment like a state-of-the-art NiTi system allows newcomers and colleagues who do not perform endodontic treatments on a regular basis to create convincing results in a short period of time.

Dentists who have not got the time or desire to personally invest in endo should nevertheless improve the service level of their practice by cooperating with a skilled and well-versed endodontic practice. In Belgium, dentists specialize in a three year intensive course to become experts in root canal treatments. Equipped with the latest instruments experienced endodontists therefore can offer a lot of advice and help with cases that are otherwise deemed to be untreatable. A good working referral system can bring huge benefits for both general practitioners and endodontists who know their way around the root canal.

Summary

Modern rotating instruments help the endodontist and general dentist to operate both confidently and safely. Refined NiTi systems with “Controlled Memory”-effect are extremely flexible and fracture resistant due to their special material properties. With pre-bendable files root canals can be shaped efficiently without making any concessions to the natural anatomy of a given root canal. Even referral cases with an eventful history can have a promising prognosis, if the RCT is performed according to the rules, i.e step by step...

about

Dr Christophe Verbanck obtained his Master of Dentistry at the University of Gent (Belgium) in 2009. He specialized in endodontology, graduating after a three year postgraduate training at the University of Gent. Since 2014 he works together with two colleagues in an endodontic practice in Hasselt (Belgium). In January 2016 he started together with his wife his own referral practice for endodontics “Lovendo” in Lovendegem (Belgium). Christophe regularly teaches general dentists in endodontics and holds workshops in the application of endodontic techniques.

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A 47-year-old female patient presented to our clinic with a radiograph that showed an extensive iatrogenic perforation of the furcation area at tooth #36 (Figs. 1 & 2) that was associated with radiographic bone loss, a vestibular fistula and pain on palpation. The patient had previously received urgent intervention concerning this tooth by another clinician owing to acute pain from pulpitis. The case was subsequently recommended for endodontic therapy.

After an initial discussion with the patient, anaesthetic was administered and the tooth was isolated. After creating a coronary access, we clinically verified the presence of pulp necrosis and perforation. The root canal was disinfected (crown-down) with an irrigation agent (5% NaOCl) and ultrasonic activation using straight tips (Irrisonic, Helse). The working length was then determined with the help of a foramen locator. The final preparation of the canal was performed with the RECIPROC system (VDW).

The prepared area was cleaned and refined with an ultrasonic diamond tip (E7D, Helse). In addition to the intra-canal disinfection process, calcium hydroxide (Ultradent) placed in the furcation area was exchanged every two weeks, during which time the symptoms were alleviated.

The obturation was performed according to the thermomechanical Tagger hybrid technique (Fig. 3) using the GutaCondensor (Maillefer), TP gutta-percha cones (DENTSPLY) and the MTA-based sealer MTA-Fill-
apex (Angelus). After the thermomechanical compaction, the gutta-percha was cut and vertical condensation was performed using a cold plugger. The area of the perforation was then cleaned and refilled with calcium hydroxide.

After 15 days, we began to seal the prepared area and initially verified that the area had dried properly. The prepared area was filled with MTA Repair HP according to the manufacturer’s instructions, applied with the MTA Applicator (both Angelus). Clinical and radiographic criteria were used to determine correct filling with the material (Figs. 4 & 5), and a glass ionomer cement (3M) was applied to seal and protect the area (Fig. 6).

After temporary restoration, we observed the tooth radiographically and found proper sealing of the furcation area with MTA Repair HP. No post-operative complications were reported.

At the two-month follow-up visit, bone formation in the furcation area was detected. No further symptoms were reported (Fig. 7).

Dr Fábio Duarte da Costa Aznar is a specialist in endodontics at the Hospital for Rehabilitation of Craniofacial Anomalies at the University of São Paulo in São Paulo, Brazil. He can be contacted at fabio@aznar.com.br.
Er,Cr:YSGG laser and Internal Root Resorptions

Case report of an endodontic treatment using radial firing fips

**Authors:** Dr Miguel Rodrigues Martins, Prof. Dr Manuel Fontes Carvalho, Prof. Dr Irene Pina-Vaz, Prof. Dr Miguel André Martins & Prof. Dr Norbert Gutknecht, Portugal/Germany

**Introduction**

Endodontic therapy is the treatment of choice for teeth with apical periodontitis and Internal Root Resorptions (IRR) as it aims to eliminate bacterial contamination, granulation tissue and blood supply of the clastic cells that are commonly reported to be involved with the process.1,2 Sodium hypochlorite (NaOCl) is arguably chosen as primary endodontic disinfection solution. Nevertheless, the ideal concentration, temperature, contact period and extent of clinical effectiveness of NaOCl remains under discussion.3,4 Moreover, several clinical factors (e.g. root perforations, absence of apical constriction etc.) may accidentally induce NaOCl extrusion into periapical tissues with potentially severe and hazardous consequences.5-9

In spite of this, several clinical strategies were reported with regards to the management of root resorptions,10 their scientific evidence is limited to case reports and few present alternative disinfection techniques.11-14 Lasers have long been presented as promising alternatives to conventional endodontic procedures.15 Each laser wavelength has a specific absorption coefficient for every tissue16 and erbium lasers demonstrate a high absorption coefficient for both water/aqueous solutions and hydroxyapatite.17, 18 Thus, the rationale for using erbium lasers in endodontics may be briefly described as: (1) the ability of infrared light to interact with aqueous solutions and produce cavitation effects capable to remove smear layer, dentinal debris and filling materials from the root canal walls19-21 and (2) the ability of infrared light to propagate into the dentinal tubules, achieving significant bactericidal effects deeper than conventional chemical solutions.22, 23

Accordingly, the 2,780 nm Er,Cr:YSGG laser has been reported as an effective method for smear layer and debris removal in comparison with EDTA irrigation, hand activation or even ultrasonic activated irrigation19, 24-27 resulting in a significant clearance of canals/isthmuses prior obturation28 and less microleakage of root canal filling materials.29 Moreover, it has also been shown to be suitable for deep
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root canal system disinfection and to allow irrigating solutions to travel apically. In addition, Er,Cr:YSGG laser irradiation has been shown to produce clinically safe temperature increments along the root canal walls, together with absence of molecular dentine changes, signs of melting or carbonisation.

Previously, laser-assisted endodontic protocols consisted of using plain fibres (with a straightforward emission beam profile). Generally, these fibres were placed in the main canal and withdrawn from apical to coronal in a rotating motion. However, such technique is known to be sensitive and to produce inconsistent results.

Designed to overcome such limitations, radial firing tips (RFT) present a beam expansion pattern—promoted by the tip geometry—that favours a homogeneous energy distribution along the root canal wall. In contrast with plain fibres, RFT have been shown to produce consistently relevant in vitro results. They are known to spread their energy in the direction of the dentinal tubules, to produce lower temperature increments, to increase cavitation effects towards the root canal walls without harming periapical tissues, to be highly efficient in bacterial and biofilm reduction and to allow irrigating solutions to travel apically by overcoming the airlock effect.

Although some clinical studies have demonstrated the potential benefits and long-term outcomes after laser-assisted treatments, there is no mention of any IRR case treated with a laser-assisted technique. The report of distinct clinical cases with long-term follow-ups may be an additional support for an evidence-based proof of concept.

**Case report**

A 31-year-old female patient presented for consultation, complaining of recurrent swelling and painful episodes related to tooth 11, which had been treated with antibiotic prescriptions over the past few years. The patient’s medical history was non-contributory. The patient reported trauma to her upper teeth when she was 20 years old. After performing clinical and radiographic examinations, tooth 11 was diagnosed with pulp necrosis with internal root resorption and apical periodontitis. The tooth was slightly tender to percussion, periodontal probing depths were considered normal (< 3 mm), and there was no discoloration (Figs. 1 & 2).

Approval for the study protocol (N_682/068) was obtained. Treatment options were discussed and the required consent obtained (Helsinki Declaration, revised in Edinburgh 2000). No financial incentive was offered (i.e., patient was responsible for the usual root canal treatment fee).

Under local anaesthesia (2% lidocaine with 1:100,000 epinephrine, Scandonest, Saint Maur des Fossés, France) and rubber-dam isolation (Hygenic Non-Latex Rubber Dam, Coltène/Whaledent, Germany), an access cavity was prepared with a high-speed carbide bur (SS White, Lakewood, NJ) and Zekrya Endo burs (DENTSPLY Maillefer, Ballaigues, Switzerland). The working length (WL) was electronically established (Root Zx mini, Morita, USA) as 1 mm short of the biological apex of the root and confirmed by radiography. No bleeding was noted from the root canal. Patency was confirmed with an ISO#20 K-file and root canal preparation was performed with the Protaper system (DENTSPLY Maillefer, Ballaigues, Switzerland) up to an F5 (#50.05) file.
use of Er,Cr:YSGG laser in endodontics case report

instrument. Root canal irrigation was performed between each file with 3 ml of sterile saline solution (Monoject 27G, Kendall-Covidien, USA). No chemical irrigants or inter-appointment dressings were used.

For smear layer removal and root canal disinfection, a previously reported laser-assisted protocol was adopted. Following root canal preparation, the main canal was filled with distilled water and laser irradiation was performed with the 2,780 nm Er,Cr:YSGG laser (Waterlase MD; Biolase Technology, San Clemente, CA) and radial firing Tip (RFT2 Endolase, Biolase Technology; calibration factor of 0.55) which was 270 µm in diameter, with panel settings of 0.75 W, 20 Hz (37.5 mJ), 140 µs pulse, 0% water and 0% air. The tip was placed at the working length and irradiation was performed, approximately, at the speed of 2 mm/s until it reached the most coronal part of the canal. The irradiation procedure was repeated four times: 2x with the canal filled with distilled water (for smear layer and granulation/pulp tissue removal) followed by 2x in dry conditions (to achieve deep dentine penetration and disinfection), with approximately 15 seconds between each irradiation. Afterward, a sterile cotton pellet was placed in the pulp chamber, and the access cavity was sealed with a reinforced zinc-oxide eugenol intermediate restorative material (IRM, DENTSPLY).

At the second appointment after seven days, the patient reported pain, tenderness to percussion and swelling upon questioning. Under local anaesthesia and rubber dam isolation, the canal was re-accessed. The main canal was filled with distilled water and laser irradiation was performed using a 320 µm radial firing tip (RFT3 Endolase, Biolase Technology; calibration factor of 0.85), with panel settings of 1.25 W, 20 Hz (62.5 mJ), 140 µs pulse, 0% water and 0% air. The irradiation protocol was identical to the first appointment. After irradiation, a final rinsing of sterile saline solution (3 ml) was performed, and the canal was dried with sterile paper points, checking for the absence of any suppurative or exudate. Filling was performed with a #50.05 auto-fit gutta-percha cone (DENTSPLY Maillefer, Ballaigues, Switzerland) using a down pack-backfill technique (Calamus, DENTSPLY Maillefer) and a resin-based endodontic sealer (Topseal, DENTSPLY Maillefer). Both down pack motion and gutta-percha injection were performed with low pressure and extreme caution due to the root weakness. Radiographic images were taken immediately (Fig. 3) and after one (Fig. 4), two (Fig. 5) and three years (Figs. 6 & 7). Over this follow-up period, the tooth remained completely asymptomatic and periapical healing was noticed.

Discussion

Due to its insidious pathology, the following clinical findings enabled the establishment of the diagnosis of IRR:44 initial absence of bleeding from the root canal confirming a necrotic pulp, normal probing depth (< 3 mm) and the complete resolution of apical radiolucency after endodontic treatment, followed by the cessation of the progression of resorption.

Given that there is insufficient clinical data supporting the superiority of any chemical irrigation regimen and no guidelines for the management of low-occurrence pathologies such as IRR, case reports may be of special relevance while adequately reporting new disinfection techniques and their clinical outcomes.3,45

The present protocol adopted the use of an Er,Cr:YSGG laser and innocuous irrigants (e.g. saline solution as irrigation and distilled water for laser activation). The decision was primordially based on the assumption that IRR lesions may perforate external root surfaces without being detectable on conven-
tional radiographic images, and that anatomic variations are known to significantly contribute to the occurrence of sodium hypochlorite accidents.

While trying to achieve significant bacterial reductions, our protocol contrast with that recently reported by Christo et al., which used low concentrations of NaOCl and an Er:Cr:YSGG laser-activation technique. In fact, this protocol has been shown not to improve the antibacterial effects of NaOCl and, therefore, the activation of NaOCl may seem inadequate for the management of such conditions. In accordance, it was shown that the use of Er:Cr:YSGG laser with relatively high output powers to activate irrigants such as NaOCl or EDTA may result in a high magnitude of pressure changes capable to induce irrigants extrusion during laser-activated irrigation.

In order to obtain adequate microbial control calcium hydroxide (CH) is often recommended for the management of IRR lesions. However, the use of CH as an intra-canal medication consistently fails to present improved clinical outcomes. In the present report we may support that CH medication should not be considered crucial as antimicrobial agent and neither as essential to stop the IRR progression.

In fact, the decision process for not using CH as intra-canal medication during the endodontic treatment of IRR was also supported by the following criteria: (1) no irrigation technique is completely able to remove CH from simulated internal root resorption cavities and (2) the long-term exposure to CH can cause a significant reduction in the mechanical properties of radicular dentine.

Due to their biophysical properties, lasers have long been seen as a promising disinfection tool in endodontics. However, each wavelength demonstrates different biophysical interactions with the main radicular dentine components. The high absorption coefficients in both water and hydroxyapatite may justify the selection of the Er:Cr:YSGG laser (λ=2,780 nm) for both smear layer removal and disinfection purposes. Conflicting evidence while using other wavelengths can be found consistently.

In the present report, the laser protocol consisted in two irradiations with distilled water in the main canal followed by two irradiations in dry conditions, respectively for smear layer removal and disinfection purposes. The rationale was that in wet conditions the Er:Cr:YSGG laser can promote beneficial cavitation effects inside the main canal without increasing the extrusion of irrigants. Moreover, water-mediated cavitation has been shown to be highly effective for the removal of dentin debris in comparison with conventional or passive ultrasonic irrigation.

RFT have been shown to overcome several limitations attributed to bare fibres, distributing the emitted laser energy in a uniform ring-shaped pattern. In similarity with any other innovative root canal treatment strategies, there are few reports demonstrating the prospective, long-term clinical outcomes associated with the use of Er:Cr:YSGG laser, namely with RFT. However, Martins et al. have shown that RFT can be considered predictable as the concomitant use of 3 % NaOCl and CH for the endodontic treatment of single-rooted teeth with apical periodontitis. Our findings may provide further evidence that RFT can be considered safe in cases of teeth with wide apical foramina while being adequate to effectively reach all the contours of the resorption lesion.

The prognosis for the conservative treatment of IRR should increase due to the report of alternative endodontic techniques along with the use of new technologies (Al-Momani & Nixon 2013, Khajastepour et al. 2015, Nilsson et al. 2013). Therefore, clinicians may consider this laser-assisted technique while selecting an appropriate endodontic disinfection strategy for the management of IRR.

Conclusion

Despite their intrinsic methodological limitations, the adequate report of single clinical cases may either help the understanding of unusual presentations of common diseases or assist in guiding new treatment concepts into clinical practice. This case report presents potential benefits towards the use of Er:Cr:YSGG laser and radial firing tips in endodontics. Further randomised clinical trials should be conducted to clearly demonstrate its effectiveness.

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

contact

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The role of the operating microscope in conjunction with ultrasonic in preparation of root canal systems

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Introduction

The purpose of preparing of the root canal system is well understood and contemporary techniques involve the use of both hand and rotary instruments used in conjunction with an irrigation regime. However, the complexity and variability of root canal morphology can make effective preparation very challenging, particularly in canals with irregular cross sections.

Current techniques are not always completely effective and it has been well recognised that while some part of the root canal are over prepared with rotary instrumentation, other surfaces are not touched. One study concluded that at least 35% of the surface area of canals had remained untouched by rotary preparation (Peters et al., 2001). In another study the results were even worse, 60–80% untreated surfaces were left in the distal canals of lower molars, with 65–75% in the apical 4 mm after preparation (Paque et al., 2010). Oval canals are particularly challenging as the debris collects in the extensions and in isthmuses (Figs. 1a & b).

A review of preparation techniques states that “because of limited efficacy of irrigation in such recesses, debris and smear layer may accumulate and remain on these unprepared root canals walls, decrease the quality of obturation and jeopardise the long-term treatment success” (Hulsmann et al., 2005).

Fig. 1a: Debris left after root treatment of distal canal of a lower molar.
Fig. 1b: Radiograph of failed root canal treatment shown in Fig. 1a.
Preparation of root canal system

The cause of failure of endodontic treatment has been attributed to the presence of microorganisms persisting in the apical part of the root canal (Siqueira 2001). Much attention has therefore been focused on preparation and obturation of the apical part of the canal thereby depending on the apical seal to prevent toxins from leaking out into the periapical tissues. While success rates of endodontically treated teeth without periapical lesions is very high, there can be a significant reduction in success in both teeth with periapical periodontitis and in those teeth where endodontic treatment has failed (Ng et al., 2011). This is predominantly due to the failure to remove microbes from the root canal system. The quest is to find more effective irrigants and irrigation techniques, as well as rotary files and preparation techniques to overcome these difficulties.

An ideal preparation shape with a rotary instrument can only be achieved in a canal with a matched cross section. Many canals are variable in shape. They may have irregular and oval cross-sections and while much of the debris is captured within the flutes of the instruments, some is compacted into those spaces between the instrument and the canal wall (Fig. 2). The incidence of isthmuses in both maxillary and mandibular first molars is very high (von Arx 2005). They are particularly liable to have an accumulation of compacted debris after preparation and the inability to clean these areas effectively has been implicated as a major cause of failure of root canal treatment, particularly in both mandibular and maxillary first molars (Fig. 3) (Hsu & Kim, 1997; Tam & Yu, 2002).

The more the debris is compacted, the more difficult it is for chemicals such as sodium hypochlorite and calcium hydroxide to penetrate through the interface. Paque et al. (2010) reported that approximately half of the debris that accumulated during rotary instrumentation of the mesial canals of lower molars remained in the canal system after irrigation.

Failure of endodontic treatment in maxillary molars has been attributed to the failure to locate and treat the mb2 canal (Weine, 1969; Wolcott et al., 2005). Various studies have shown the presence of the mb2 canal in up to 90% of maxillary first molars. A study by Somma et al. (2009) showed that in 58% of teeth, the mb1 and mb2 merge apically into one canal. In a proportion of these failed cases where the mb1 canal has been located, cleaned, shaped and obturated well, the question should be asked, “Was the failure due to inadequate treatment of the apical part of the mb1 canal, or because the mb2 canal and isthmus between the two canals had been missed?” Identification and treatment of the mb2 canal with concomitant re-treatment of the mb1 canal often leads to healing. This suggests that the seals are not always good enough to “entomb” the bacteria. Indeed coronal microleakage has been implicated as a major cause of failure of endodontic treatment (Saunders and Saunders, 1990). Undoubtedly tracts of debris running along side root fillings are conduits for bacteria to cause failure by this method.

In an in vivo study by Nair (2005) the mesial canals of sixteen lower molars with infected root canals were root treated by conventional techniques in a single visit and the apical portions removed by flap surgery and evaluated by corrective light and transmission electron microscopy. In the majority of cases residual microbes were located in inaccessible recesses, uninstrumented areas of the main canals, accessory canals and intercanal isthmuses.

If the lateral extensions feed into the apical part of the canal, then removing bacteria and nutrients from these areas reduces the bacterial load and this has to be beneficial for the outcome of treatment. A variety of techniques have been proposed to overcome the inadequacies of mechanical preparation in non-circular ca-
Among the numerous irrigation techniques that have also been proposed there are those that include circumferential filing using both hand and rotary files and the use of a rotary self-adjusting file that adjusts to the shape of the canal. The SAF system has been shown to be more effective in cleaning oval canals that conventional rotary nickel titanium instruments, however, in the study by De Deus et al. (2011) using mandibular canines, even this technique did not render the canals completely clean. They showed that rotary files were unable to access the recesses of oval canals and that sodium hypochlorite had a “limited ability to compensate for the inadequacy of the file itself.” They further suggested that the common belief that “the file shapes; the irrigant cleans” is based more on wishful thinking than on experimental facts. In a review article by Metzger (2014), it was recognised that SAF was unable to prepare the narrow isthmus of less than 0.2 mm. In the case of the narrow isthmus the challenge is to deliver sufficient quantities of irrigant effectively into a very small area in which debris has been compacted during preparation.

Recently new concept files XP3-DFinisher (Brassler, USA) that change their shape with temperature have been developed with the expectation that they can deal with canal irregularities. While these may be helpful in removing soft tissue in non-circular canals, they may be of limited value in situations where tissue or root filling materials are strongly adherent to the root canal wall.

Among the numerous irrigation techniques that have also been proposed there are those that include the use of ultrasonic energy. Ultrasonic have played a role in endodontics for many years. Initially ultrasonic canal preparation was introduced by Richman (1957) and in subsequent years there was a vogue for using the ultrasonically energised file to cut dentine in root canals. The technique fell out of favour because lack of control produced ledges, apical perforations and instrument separation (Lumley et al., 1992). In the 1980s research showed that passive ultrasonic energy, PUI renders canals clean more effectively than ultrasonic irrigation with simultaneous instrumentation (UI), where the file is intentionally brought into contact with the canal wall (Weller et al., 1980; Ahmad et al., 1987a). PUI uses an ultrasonically energised file to irrigate the canal and to remove debris utilising a combination of acoustic microstreaming and cavitation energy (Ahmad et al., 1987a, b; 1988; 1992) (Fig. 4).

PUI was found to be effective in apical part of curved canals and in the isthmus area between two canals. The technique has been shown to remove tissue more effectively than hand irrigation and does not cause damage to the canal wall (Gutarts et al., 2005). Variation in the efficacy of PUI reported in some studies were explained by difficulties in standardising the position of the instrument in the centre of the canal (van der Sluis, 2007).

Since the introduction of the operating microscope, it has been possible to carry out endodontic treatment at varying magnifications up to approximately 25x with the aid of direct light that can penetrate into the depths of the root canal. This means that visual inspection of the prepared root canal is possible. Once the canal has been shaped by conventional techniques and dried, the canal can be visually inspected both apically and laterally into the extensions of the canal. Straight canals can be inspected to the apical constriction. Since the rotary files straighten the coronal and middle thirds of curved canals, most of these prepared canals can be inspected to within a few millimetres of their full working length.

Inspection through the microscope at about 10x and above can identify those parts of the canal system that have not been touched by the rotary files and contain residual tissue (Fig. 5). These are usually the extensions of oval and flattened canals, isthmuses and fins.

The challenge is to prepare these areas producing a smooth predictable shape, without removing excessive tissue, allowing irrigants to penetrate into the canals more fully and therefore producing cleaner canals. Our expectations are that delivery of irrigants and medicaments using a variety of techniques into these parts of the canal anatomy will digest residual tissue material and entomb remaining bacteria, rendering them ineffective. While they have undeniable advantages in the parts of the canal system cannot be inspected under the microscope, a significant part of the bacterial load within the canal can be removed by the use of a cutting instrument directed towards a specific part of the root canal such as a fin or isthmus. In the coronal part of the canal this can be done with either a long shank rosehead bur or a dedicated ultrasonic instrument. Long shank burs are very limited in their use, however because of the length of the shank, relatively large diameter of the bur, lack of visual access and they can only be used in the straight part of the canal. In the deeper parts of the canal ultrasonically activated instruments can be used to great effect.
A very effective solution is to use an ultrasonically energised K-file (UEFK), the very instrument that was discarded after the problems identified with ultrasonic instrumentation in the 1980s. The difference between then and now is in conjunction with the use of the operating microscope the instrument can be used with a great deal of control. Also power settings have been considerably reduced to minimise the possibility of instrument separation. In many situations the UEKF overcomes many of the limitations presented by other ultrasonic instruments. The file can be curved in multiple directions so that the head of the ultrasonic handpiece does not impair visual access and the file can be shaped to follow the curvature of the canal. When used in conjunction with the operating microscope, the file can be directed to the part of the canal that has not been prepared by the rotary files. A size 20 UEKF with a 2% taper is an optimal size although occasionally a larger file may be used. Because the file is relatively flexible and removes only 0.2 mm of tissue, unnecessary removal of dentine is kept to a minimum (Fig. 6).

The file works in multiple ways; it can be easily pre-curved to follow the canal curvature and can be used as either a cutting instrument by engaging the tip or as a planning instrument by using the flutes along its working length. When used as a planning instrument, it can be used with variable pressure against the walls of the canal such as in an oval canal extension or in an isthmus. The greater the pressure applied, the more effectively the file cuts dentine in the same way as a hand file, at the expense of the ultrasonic effect. As the pressure on the file is reduced, so the ultrasonic effect is increased, achieving the benefits of PUI. The effectiveness of this technique is enhanced by both the flexibility of the K-file so that it can be pre-curved and by its rigidity so that it can cut efficiently into a targeted area. The instrument can be used in both modes interchangeably just by varying the lateral pressure placed on the ultrasonic handpiece.

In endodontic retreatment cases both the UEKF and the dedicated ultrasonic tips can be used to great effect to remove endodontic obturation materials, separated instruments and posts using minimally invasive techniques. While the UEKF has to be used at low power settings to minimise the possibility of fracture, it allows for excellent visual control. The dedicated ultrasonic tips such as the EndoSuccess ET 25 tip can be precuredved to improve visual access and can be used at higher power settings. It is however only effective at its end. This tip is particularly useful for removing separated instruments. Other ultrasonic tips that cannot be pre-curved can only be used in straight parts of the canal.

The removal of gutta-percha from oval canals often presents a challenge as rotary instruments are not completely effective. A rigid ultrasonic tip is more like to plasticise the gutta-percha, while the UEKF with its increased tip amplitude, fragments the material.

Conclusion

Both ultrasonic and the microscope have become an essential part of the armamentarium in endodontics. When used together they can produce minimally invasive preparations, which produce cleaner canals in both primary and retreatment cases. Conventional irrigation strategies should always be employed, particularly in those areas of the canal system that cannot be visually inspected with the operating microscope such as in the curved apical third. However, the technique described above can aid in the reduction of the bacterial load within the canal system and this can result in more predictable outcomes.

Editorial note: A complete list of references are available from the publisher.
META BIOMED: Envision the future

Since its establishment in 1990, META BIOMED has earned a reputation for being one of the dental industry’s leading technological innovators. A strong emphasis on research and development has led to breakthroughs in dental materials, equipment and biomaterials. This trend continues with two of its latest products: the i-ROOT electronic apex locator and the E&Q Master cordless gutta-percha obturator. Another product will soon be released.

I-ROOT offers unparalleled accuracy in the measurement of apical constrictions. Using dual frequency, i-ROOT is the fifth-generation apex locator from META BIOMED. It is able to measure accurately regardless of the root canal’s condition—whether it is dry, wet or bleeding, or in the presence of a saline solution, EDTA, NaOCl or chlorhexidine. The device has a colored display that allows for greater detail, with audio measurement. Developed and upgraded with the technology of the e-Magic Finder (EMF-100 series) apex locator, it is simple to operate. The locator is powered by three AA batteries and provides up to 60 hours of continuous use. Weighing only 390 g, i-ROOT is the ideal portable, durable and user-friendly apex locator.

The E&Q Master is designed to be user-friendly in every aspect. Its slim design with a firm grip allows for easy handling, and its simple method of operation can be learned quickly. The obturator runs at a low voltage, making it safe to use, and it is able to perform continuously for 90 minutes. Its lithium-ion battery charges within 3 hours in a similar manner to a mobile phone. The thermo-plasticized method of filling the canal allows the device to provide fast treatment, as it is ready for use within 2 minutes. Finally, META BIOMED is proud to announce another new system for continuous wave obturation that will soon be released internationally: the EQ-V obturation gun and pen combine simple use, chemically proven housing material, outstanding heating performance, extended battery time, and ergonomic design. Among other features, the gun’s innovative 360 degree rotating cartridge needle provides dental professionals with the best choice for obturation. “Both disposable and reusable cartridges will be available, so doctors can easily apply the technique for 3-D obturation. Thanks to EQ-V, all levels and ages of dentists will enjoy root canal filling with great success. We ultimately target to replace conventional techniques with our low-cost cartridge solutions,” says Ian Yun, Managing Director at META BIOMED Inc.

META BIOMED Co Ltd.
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The new XP-endo Shaper, developed by Swiss dental manufacturer FKG Dentaire, is an innovative single-file system indicated for shaping the vast majority of root canals in three dimensions.

Providing ease of use, swiftness, effectiveness and resistance to cyclic fatigue, the XP-endo Shaper is designed to facilitate the clinicians’ work while maximising endodontic treatment quality and safety. Manufactured from the patented MaxWire alloy, it features extreme flexibility and remarkable fatigue strength, compared with competing instruments that achieve the same final size. It has the capacity to expand, from its initial 0.01 taper to a minimum taper of 0.04, and the ability to progress with agility along the canal, reducing the risk of torsional fatigue. Featuring the Booster Tip, which has six cutting edges, the XP-endo Shaper starts shaping at ISO diameter 15 and then increases its working scope to achieve ISO diameter 30. The Booster Tip keeps the instrument centred and avoids ledging or straightening of the root canal.

Owing to the instrument’s small core diameter, its cutting efficiency and the stream generated in the irrigation fluid, a large amount of dentine micro-debris is evacuated efficiently. This prevents the risk of debris compaction into canal irregularities and limits the extrusion beyond the apex. Used after preparing a glide path to a minimum ISO 15/02, the XP-endo Shaper can achieve a final canal preparation size of at least ISO 30/04. These technical advantages, combined with high-speed continuous rotation and minimum torque, minimise the stresses exerted on the canal walls and prevent the risk of microcracks. The XP-endo Shaper has a gentle, non-aggressive action and promotes conservative procedures.

With this new instrument, FKG enables general dentists and endodontists to perform root canal shaping simply, quickly, safely and with just one instrument. Available in 21, 25 and 31 mm lengths, the XP-endo Shaper comes in sterile blister packs of six instruments.

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(XP-endo Shaper is a registered trademark of FKG Dentaire.)
Endodontic imaging mode from Planmeca yields detailed images without noise or artefacts

Planmeca has in its offer an imaging mode specially developed for use in endodontics and that is ideal for cases dealing with small anatomical details, such as imaging of the ear. The imaging mode is available for all Planmeca ProMax 3D family units and provides perfect visualisation of even the smallest anatomical details. The program produces extremely high-resolution images with a very small voxel size (only 75 µm). Owing to the intelligent Planmeca AINO noise removal and Planmeca ARA artefact removal algorithms, noise-free and crystal clear images are produced.

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A particularly low radiation dose or small voxel size can cause noise in 3-D X-ray images. The Planmeca AINO Adaptive Image Noise Optimiser is an intelligent noise filter that reduces noise in CBCT images without losing valuable details. The filter improves image quality in the endodontic imaging mode, where noise is inherent due to the extremely small voxel size. It is especially useful when used in accordance with the Planmeca Ultra Low Dose protocol, where noise is induced by the particularly low dose. Planmeca AINO also allows the reduction of exposure values and consequently the radiation dose in all other imaging modes.

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Shifting borders for a successful “endo”

The International Dental Show makes it visible

Current trends in endodontics—mechanical preparation—opportunities for specialisation—the latest status in endodontics—modern diagnostics and therapy concepts—a key theme of IDS

The scientific and technological progress in the field of endodontics has considerably improved the chances of long-term tooth preservation and also turns this specialised field into a relevant part of prophylaxis-oriented dentistry. Because the success rates are significantly higher today than twenty years ago. Whereby the methodical spectrum ranges from the conserving therapy with manual or mechanical root canal treatment, disinfection and obturation, to the possibly necessary root canal revision, through to minimally invasive, microsurgical concepts for the treatment of specific endoperiodontal lesions. The International Dental Show (IDS) from 21 to 25 March 2017 will present the entire palette of endodontic instruments and materials necessary for this purpose.

Getting to know the root canal system: Glide path and diagnostic tools

This begins with systems for the production of the gliding path as a basis of every successful endodontic treatment. To this end both hand files and chelation gels as well as machine-driven alternatives are available. A trend towards the use of a single rotating single-use file is noticeable, because modern instruments made of nickel titanium display high resistance to breakage, can reduce the treatment time and are thus also advantageous from an economic point of view.

In this stadium of the treatment the dentist already gets a precise picture of the anatomy of the root canal—not least thanks to a multitude of diagnostic aids. For the visual examination with the bare eye, the dentist can use a magnifying glass for the inspection, whereby today extremely lightweight high-tech models enable a particularly relaxed view even in the case of very small-structured areas. If necessary, the practitioner chooses a colour corrected lens system and a correction to suit his spectacles.

The endodontic X-ray—more and more frequently in the form of a digital 3-D X-ray—delivers essential additional information on the precise course of the root canal. In the further process, X-rays frequently serve the purpose of determining the exact length, whereby the combination with an electro-metrical determination with an endometric device proves to be helpful in many cases. Electrical resistance represents the actual measuring sizes here. In the case of more recent endometrical devices, a reference point between the foramen physiologicum and the foramen apicale is determined. The actual measurement of the resistance is thus only dependent on the conductivity of the canal wall dentine. State-of-the-art developments work according to the principle of the impedance quotient measurement: These apex locators determine the alternating current resistance in the case of two different frequencies (multi-frequency technology). For practical use, devices that communicate the message “apical section reached!” or “Beware, danger of over-instrumentation!” using acoustic and/or optical signals are recommended. Modern apex locators work in both dry and moist root canals and are in some cases even available in compact small formats.

Less and less filing needed to achieve the goal

In order to prepare the root canal, sequences of coordinated filing are required—however this is tending...
to become less all the time or—an important development of our era—only one sequence of filing is needed even. Depending on the individual case and personal experience, the practitioner decides between classic rotating filing with a high degree of flexibility and if necessary increased breakage resistance (continually rotating movement) and an effective and simple process (reciprocating file movement).

Depending on the filing system, classic endo motors can be implemented or advanced systems that can work either continually or reciprocally. Alternatively to the usual touch-screen operating surface, in some models it is possible to steer them per Bluetooth via an app from the iPad Mini. This can make the storage of filing sequences, the graphic representation of treatment scenarios to the patient much easier.

With the subsequent rinsing of the treated canals (i.e. with NaOCl, EDTA) numerous details have been optimised over the past years—one of them: The formation of and the related limited flow of fluid around it is avoided by activating the rinsing fluid. This is made possible by a pressure/vacuum rinsing or by combined vibrating and swaying movements with selectable sequences. The suitable devices normally comprise of a handpiece (possibly cordless) and special inserts/attachments. In some cases these can be bent to suit the canal anatomy and then inserted. This can lead to the achievement of the desired clean surface with open dentine tubules.

The next partial goal is the hermetic sealing of the canal system. Usually this is carried out using gutta-percha, whereby both systems for the lateral condensation or the multi-fill technique as well as for the one post, two material method (flexible plastic carrier + heated gutta-percha) can be implemented. Thanks to the obturation options available today, they can frequently be carried out in such a forward-looking way that a possible revision is even facilitated.

**Strongly co-decisive:**
**Posts and coronal provision**

Finally, the quality of the coronal restorations also plays a decisive role for the overall success of the “endo”. If after the preparation a small amount of natural tooth substance remains (i.e. no more cavity wall or at the most one single wall), it is worth considering implementing a post to stabilise the tooth, if necessary after applying a dentine pin (usually 2 mm high). There is a wide selection here: Posts made out of zirconium oxide fibreglass with a 10–20% resin content, out of different fibreglass/resin mixtures, out of pre-silanized fibreglass reinforced composites, etc. and in different geometrical executions, for example conical, cylindrical, optionally with an activated thread or with a separate head (two-piece), conically cylindrical or with a double taper design with a slightly less conical lower third. Several posts behave like a chameleon and display a colour coding at room temperature to enable a safe recognition, only to take on the colour of the natural tooth at body temperature.

Last, but not least: After the “endo” is before the “post-endo”. The final coronal care has to be hermetically sealed and must remain stable long-term. Here the practitioner can choose between the conventional prosthetic materials, classic filling materials and (except for the formation of posts) bulk filling composites.

**Borderline:**
**Special area endo/perio lesion**

The endoperiodontal lesions generally constitute a significant borderline case because in the individual cases the therapy is strongly dependent on the cause. If it is primarily due to a periodontal inflammation, both endodontic treatment and a curettage will be required. However, if the cause of the disease in the respective tooth is primarily endodontic, root canal treatment could suffice and a curettage should not be carried out. Comprehensive probing and a high-performance microscope aid the differential diagnosis.

 Whereas in the case of endodontic treatment a host of individual decisions have to be taken. Manual or mechanical production of the glide path? Preparation with multi-filing or one-time filing systems? Root post or not? Restoration of the crown using composites or prosthetics? A series of predecisions could be taken at the International Dental Show in Cologne from 21 to 25 March 2017, because the different processes, products and ultimately an abundance of endo experts will be available.

“The desire to preserve one’s own teeth up until an advanced age is growing within the population. Thanks to the progress of the past years, there have been shifts in the borders in the field of endodontics: What was considered to be a healing attempt or even a “risk” five or ten years ago, has often become a challenge today that can be mastered. As the leading trade fair for dentistry and dentist technology, IDS, from 21 to 25 March 2017, shows which innovations are carrying on this trend—the entire spectrum of modern endodontics and the current therapy and diagnostic developments,” said Dr. Martin Rickert, Chairman of the VDDI.

IDS (International Dental Show) takes place in Cologne every two years and is organised by the GFDI Gesellschaft zur Förderung der Dental-Industrie mbH, the commercial enterprise of the Association of German Dental Manufacturers (VDDI) and staged by Koelnmesse GmbH, Cologne.

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*Image courtesy of Koelnmesse.*
International Events

2016

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

ROOTS Summit
30 November–3 December 2016
Dubai, UAE
www.roots-summit.com

Austrian Society of Endodontology Annual Meeting
2–3 December 2016
Vienna, Austria
www.oegendo.at

2017

Swiss Society for Endodontology—Annual Conference
20–21 January 2017
Bern, Switzerland
www.endodontology.ch

Irish Endodontic Society—Annual Scientific Meeting
26–27 January 2017
Dublin, Ireland
www.irishendodonticsociety.com

AEEDC 2017
7–9 February 2017
Dubai, UAE
www.aecdccom

IDS
21–25 March 2017
Cologne, Germany
www.ids-co logne.de

Asia Pacific Dental Congress (APDC)—9th Scientific Congress of Asia Pacific Endodontic Confederation and 18th IACDE & IES PG Convention
5–8 April 2017
New Dehli, India
www.apec2017.in

Libanese Society of Endodontology—12th International Scientific Meeting
7–8 April 2017
Beirut, Lebanon
www.lse-lebanon.org

American Association of Endodontists—AAE17
26–29 April 2017
New Orleans, USA
www.aae.org

Finnendo 2017
11–12 May 2017
Helsinki, Finland
www.finnendo.fi

18th ESE Biennial Congress
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Questions?

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