Laser Endodontic debridement and canal disinfection

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The canal system within teeth is a complex array of accessory and lateral canals, fins and other anatomical areas inaccessible to endodontic files. (Figure 1) The principle that only one thing can occupy a space at a time is key to endodontic success. This is dependant on disinfection and debridement of the canal system as well as how well the system is sealed during obturation. Irrigation has been long accepted as a key part of treatment to achieve those goals. Yet, complete clearing of residual bacteria especially in the apical portion of the canal system has been difficult to achieve with traditional methods using even sodium hypochlorite (NaOCL) solutions. (Figure 2) Studies have demonstrated that addition of a Er:YAG laser to activate the irrigation solution greatly increases not only the efficiency of the irrigation solutions advocated (NaOCL and EDTA) but also improves disinfection of the canal system. (Figure 3)

Laser enhanced irrigation

The Er:YAG laser (LiteTouch™, distributed in USA by AMD LASERS, Indianapolis, IN) creates hydrodynamic pressure following cavitation bubble expansion and collapse when the irrigation solution is activated in the chamber. The LiteTouch™ Er: YAG laser energy is set at a sub-ablative power level which allows its use without structural changes to the hard tissue within the tooth, eliminating the risks of ledging and perforation of the pulpal floor. When activated a heat pulse is generated by laser radiation delivered via a sapphire tip into an absorbing liquid (irrigant). This results in tensile stress and cavitation being induced in front of the tip at a distance far below the optical penetration depth of the laser radiation. Bubble expansion and collapse cause the surrounding fluid to flow at a speed of up to 12 m/s traveling throughout the canal system. This causes rapid displacement of intra-canal fluid via radial and longitudinal pressures sufficient to drive irrigant into the canal anatomy and clean dentinal walls significantly. The photomechanical

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Figure 1: Anatomy of the canal system demonstrating accessory canals, fins and lateral canals which are not accessible with endodontic files as shown in cleared teeth.

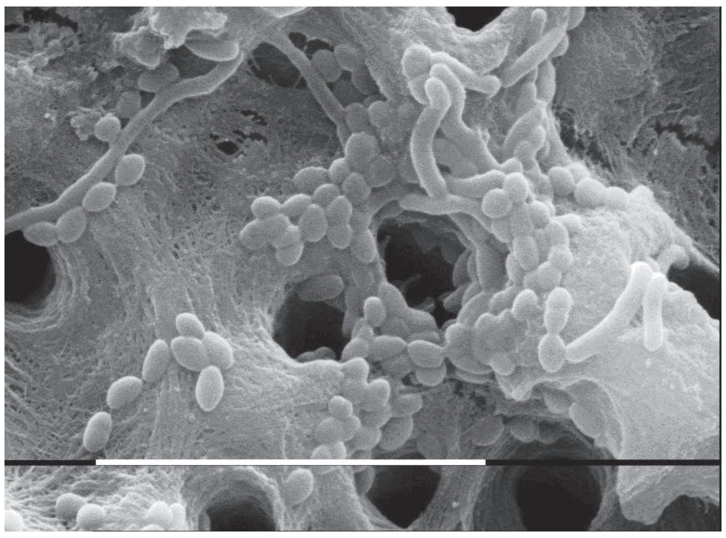

Figure 2: SEM showing bacteria and pulpal debris in the apical 1/3 that was not able to be removed fully using standard irrigation protocol. (Courtesy Prof. Georgi Tomov, Plodiv, Bulgaria)

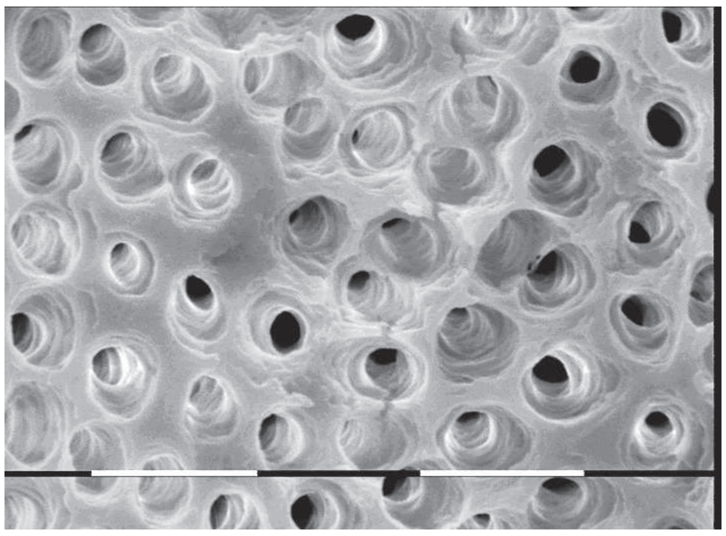

Figure 3: SEM showing complete removal of bacteria and pulpal tissue in the apical 1/3 after irrigation using the LT-IPI™ protocol. (Courtesy Prof. Georgi Tomov, Plodiv, Bulgaria)

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activation of the irrigant includes a temperature rise in the irrigant increasing its effectiveness in debridement of dentinal walls and increase of chemical properties of the irrigants.

LiteTouch™ Induced Photomechanical Irrigation (LT-IPI ™)

Endodontic treatment is initiated with access to the pulp chamber, which may be performed by traditional methods using burs or by ablation of the enamel and dentin with the LiteTouch™ Er:YAG laser. As the laser is ineffective in removal of ceramics and metals, such as those used in fixed prosthetics and also amalgam, carbides and diamonds are needed create access through these materials. Once dentin has been reached the laser may be utilized to unroof the pulp chamber (hard tissue mode). An additional benefit of the Er:YAG laser to access the pulp chamber is it provides decontamination and removal of bacterial debris and pulpal tissue to yield a cleaner chamber aiding it identification of the canal orifices (soft tissue mode).

Once the canal orifices are identified hand files are utilized to establish a glide path to the apical working length in each canal. Canals are then enlarged to the desired ISO canal size with either hand or rotary files. (Figure 4A) Laser-assisted canal irrigation requires canal preparation to an apical preparation ISO 25/30. Taper of 0.04 or 0.06 for the final instrumentation is recommended. Sodium hypochlorite (NaOCL) is utilized within the chamber and canals during instrumentation both as a pulpal tissue dissolvent and to lubricate the files within the canal, decreasing the potential of file separation that can occur when instrumenting a dry canal. (Figure 4B)

Photo-activation of the irrigant within the canal system using the Er:YAG laser with a 0.4/17 or 0.6/17mm tip assists in removal of the debris created by the files. Between each rotary file, the chamber is filled with NaOCL and the tip of the laser is placed into the chamber and the solution activated with the laser at 40mJ at 10Hz with an average power of only 0.5W for 20 seconds. (Figure 4C) The chamber is suctioned and fresh NaOCL is placed into the tooth and the next file is used for instrumentation. It is unnecessary to place the lasers tip into the canal, as activation of the solution within the chamber transmits down the irrigant in the canals to the apical aspect of the roots. Laser activation may also be performed with 17% EDTA solution alternated with NaOCL. The benefit of EDTA solution is its chelation effect opening canal anatomy so that the next round of NaOCL can reach more pulpal tissue not accessible to the files in fins, as well as accessory and lateral canals. Following final instrumentation of the canals with rotary files, the chamber is filled with NaOCL and the Er:YAG tip is placed into the chamber again and activated for a minimum of 60 seconds. This allows the photo-activated irrigant clear debris and remaining pulpal tissue from the complete canal system. The irrigation solution is suctioned from the chamber and fresh irrigant placed and photo-activation repeated until no visible debris (cloudiness) is noted in the chamber fluid. Any remaining solution is suctioned from the tooth and the canals are dried with paper points. Obturation is then accomplished using the practitioners preferred method and materials allowing obturation of anatomy inaccessible by instrumentation with files. (Figure 5) DT

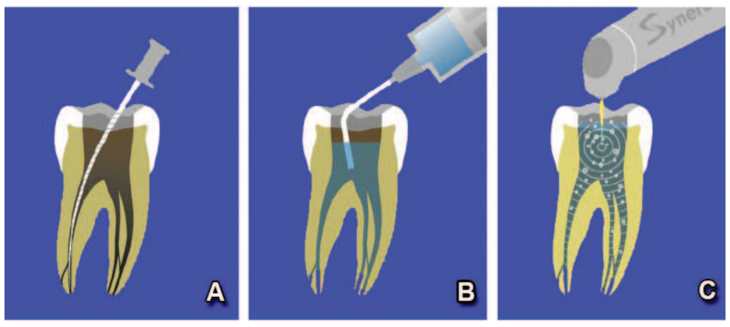

Figure 4: LiteTouch™ Induced Photomechanical Irrigation protocol (LT-IPI™): Establishment of glide path with hand files (A), Canal and chamber filled with NaOCL (B) and Placement of the LiteTouch™ tip into the irrigant in the chamber and activation of the Er:YAG laser. (Illustrations: courtesy of Dr Parvan Voynov, Plodiv, Bulgaria)

Figure 5: Accessory anatomy evident in the apical that has been filled with sealer accessible due to use of the LiteTouch™ Er:YAG laser. (Photo courtesy of Dr. David Guex, Lyon, France)

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He is in private general practice in Silver Spring, Maryland and a former Assistant Clinical Professor at University of Maryland and a former AAID Implant Maxi-Course. He is aslo assistant program director at Howard University College of Dentistry. He has lectured internationally on the topics of Restorative dentistry, Endodontics and Implant surgery and prosthetics, removable and fixed prosthetics, Periodontics and has over 460 published articles. He has earned Fellowship in the AGD, ACD, ICOI, Pierre Fauchard, ADI, Mastership in the AGD and ICOI and Diplomat status in the ICOI and American Dental Implant Association (ADIA).