Successful endodontic treatment depends upon maximal debridement and disinfection of the entire root canal system. The root canal system must be shaped to a convention that permits adequate cleaning and disinfection by elimination of microbes. The literature is clear that as much as 35 percent or more of the root canal system remains untouched by any instrumentation technique. Essentially no filing technique allows instruments to sculpt all canal walls and remove infected dentin. To decrease the bacterial load and achieve better debridement, irrigation protocols are used to purify to the PIPS protocol are not required to clean the canal walls with a higher energy level than ultrasonic files. By applying the PIPS laser to pulse extremely low energy levels, the extremely low energy needed to ablate the smear layer from canal walls. Irrigants in the access cavity and outside the root canal system, the extremely low energy needed to activate the Er:YAG laser is below the threshold of ablation for dentin. Legging and thermal effects that have plagued the widespread use of other laser systems is completely avoided at the energy levels used by the PIPS technique. A new application of Laser-Activated Irrigation (LAI) has been recently introduced. Photon Induced Photoacoustic Streaming (PIPS) uses an Erbium 2,940 nm laser to pulse extremely low energy levels of laser light to generate photoacoustic streaming, which streams irrigants throughout the entire root canal system. Using extremely short bursts of peak power, laser energy is directed down into the canal and the action actively pumps the tissue debris out of the canals while cleaning, disinfecting and sterilizing each main canal, lateral canals, dentinal tubules and canal anastomoses to the apices. This movement of irrigant is achieved without the need to place the radial and strip-tipped laser (PIPS) tip, Fig. 2, into the canal itself, as with other conventional hand and ultrasonic systems.

The tip is held stationary in the coronal aspect of the access preparation only. With the irrigant occupying the entire root canal system, the shock wave created by PIPS travels in all directions during activation and effectively debrides and removes organic tissue remnants. Through this laser-activated turbulent flow, remineralization, following the PIPS protocol are not required to place the tip into each canal, thus eliminating the need to enlarge and remove more tooth structure to deliver standard needle irrigation to the smaller and more delicate apical anatomy, commonly seen in the apical one-third. The results are canal convenience forms that are more conservative, minimally invasive and biomimetic (Fig. 3), preventing the unnecessary removal of tooth structure. Unlike other laser-activated irrigation techniques, PIPS is not a thermal event, rather subablative. Properly executed, PIPS creates turbulent photoacoustic agitators of irrigants that move fluids three dimensionally throughout the root canal system even as far as the apical terminus, distant from the radial strip-tipped tip location. By activating the tip in the access cavity and outside the root canal system, the extremely low energy needed to activate the Er:YAG laser is below the threshold of ablation for dentin. Legging and thermal effects that have plagued the widespread use of other laser systems is completely avoided at the energy levels used by the PIPS technique.

Recent testing, performed at the University of Tennessee by Dr. Adam Lloyd, chairman of the department for endodontics, objectively confirmed the improved cleaning and debridement of organic and inorganic tissue left by instrumentation. Microcomputed tomography scans were used to assess before and after volumetric changes in the internal space of lower first molars treated with PIPS protocol (Fig. 4). Sequential slicing beginning at 6 mm from the apex and moving down to the last 2 mm demonstrated that all slices images showed significant improvements after PIPS.

The importance of these findings is far reaching. PIPS now offers the dentist a less technique-sensitive, minimally invasive and time-reducing method for irrigating and preparing endodontic root canal systems. Because PIPS has demonstrated its ability to decontaminate and debris areas that files and instrumentation cannot reach, success rates rise and retreatment for past failures is possible.

Laser energy is also helpful in locating and helping negotiate calcified canals. PIPS is a valuable additional tool in the treatment of endodontics regardless of the shaping and obturation system used.

Laser technology used in endodontics during the past 20 years has undergone an important evolution. Research in recent years has been directed toward producing laser technologies (such as impulses of reduced length, radial firing and strip-tipped tips) and techniques (such as LAI and PIPS) that are able to simplify laser use in endodontics and minimize the undesirable thermal effects on the dentinal walls, using lower energies in the presence of chemical irrigants. EDTA has proved to be the best solution for the LAI because that activates the liquid and enhances its cleaning of the smear layer. The use of a laser (PIPS) to activate from the radial for- mation increases its antimicrobial activity. Finally, using the correct protocol, the PIPS technique reduces the thermal effects and exerts both a stronger cleaning and bactericidal action, because of its streaming of fluids initiated by the photonic energy of the laser. Further studies are currently underway to validate LAI and PIPS as innovative technologies in modern endodontics.

References

About the author

Dr. Enrico D’iVito formed his dental practice in 1990 in Scottsdale, Ariz. In 2004, he formed the Arizona Center for Laser Dentistry. He is the founder and director of the state-accredited Arizona School of Dental Assisting (ASDA). In addition to teaching at ASDA, Dr. D’Ivito is also a clinical professor at the Arizona School of Dentistry and Oral Health and is helping to create its department of laser dentistry. He earned his undergraduate degree from Arizona State University in 1980 and is a graduate of the University of the Pacific, Arthur A. Dugoni School of Dentistry with honors, receiving several clinical excellence awards. He can be reached at edivito@azcld.com.

PIPS with laser-activated irrigation

Photacooustic shockwave with irrigant debrides areas of root canal files can’t reach

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Fig. 1: Left, apical third of root treated with PIPS. Note clean surfaces without any thermal damage. Right, SEM of apical third showing extremely clean dentin tubules post PIPS with no sign of thermal damage. (Photos/Provided by Enrico D’Ivito, DDS)

Fig. 2: Left, close up of tapered and stripped PIPS tip used for laser-activated irrigation. Right, position of the laser tip in the PIPS technique: steady in the pulp chamber and does not enter canal.

Fig. 3: Left, pre-treatment. Right, post-treatment oblique section after PIPS. Tooth is isolated with #125-06 taper. Note the conservative convenience form maintaining more original anatomy of root canal system and reducing the need to use larger file sizes conserving more dentin tooth structure.

Fig. 4: Left, mandibular molar canal system showing isthmus before (A, red canal) PIPS laser-activated irrigation. Areas of organic tissue and debris from instrumentation have been completely eliminated, as highlighted by post-PIPS image (B, green canal). Right, mandibular molar with canal preparation to a size 30/04 (A, green canal) obturated with nano particle BC Sealer (Brasseler USA, Savannah, Ga.), and single cone obturation (B, blue).

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