The Diode Laser - The Diode Laser in Endodontics. - *By Dr. Glenn A. van As*

In last months edition of Dentistry Today, I discussed the value of the diode of laser for improving the success rate with pulp capping during restorative dentistry in an attempt to avoid endodontic therapy for the patient. The Picasso Lite and Picasso 7w diode lasers can be used to help with pulp exposures and deep preparations where pulp proximity exists. The disinfecting and hemostatic abilities of these lasers are beneficial to the success of restorations that encroach, or in fact directly expose the pulp. In this months article, I will stay with the same topic of the diode laser in endodontics, but this time will cover how the diode laser can be used to reduce bacteria when root canal therapy is required.

Introduction

Endodontics- "Endo" is the Greek word for "inside" and "odont" is Greek for "tooth." Endodontic treatment treats the inside of the tooth. This is the definition of endodontics from the American Academy of Endodontics (1).

Endodontic treatment is needed when the pulp, the soft tissue inside the root canal, becomes inflamed or infected. This inflammation or infection can be due to a variety of causes including extensive decay, repeated dental procedures on the tooth, fractures, cracks or trauma that encroach the pulp. In addition traumatic events that move teeth may also cause the pulp to become infected. A common denominator to many of these insults to the pulp is that microorganisms play an essential role to the development and continuation of pulpal and periapical diseases. Unfortunately, eliminating bacteria is not simple, and current modalities that include a variety of instrumentation techniques, as well as irrigation and intra-canal medications are not always effective. In addition chemicals such as bleach (NaOCl) and calcium hydroxide (CaOH2) have a limited ability to penetrate dentinal tubules to around 130 microns and require direct contact with cells to be bactericidal. In contrast, diode lasers have the ability to penetrate deeper into dentin and provide tremendous levels of bacterial reduction without actual direct contact due to the unique characteristics of laser light. Gutknecht and his group in two different studies have shown that the diode laser is able to provide almost complete intracanal bacterial elimination with a mean bacterial reduction of 74% that was achieved even at a depth of 500 microns into the tubules.(2,3) Their conclusion was that the "investigation indicates that the diode laser radiation reduces the number of bacteria in deep layers of infected root canal wall dentin." Schoop and his group confirmed that indeed diode lasers are effective in reducing the stubborn bacterial forms like Enterococcus Faecalis which is difficult to eradicate with bleach and traditional means. Indeed they concluded that "The present study demonstrates that all the wavelengths investigated are suitable for the disinfection of even the deeper layers of dentin and may prove to constitute valuable tools in state-of-the-art endodontics." (4)

The value of mechanical instrumentation in endodontics has been shown to help deliver irrigants throughout the complex anatomy of the canal systems to better help disinfect the pulp system. After instrumentation has widened the canal, an optical laser fiber of 200-400 microns (equivalent to a size 20-40 hand file) can deliver laser energy throughout the canal system. Typically, the irradiation is completed in an apical to coronal fashion moving at 1-2 mm per second. The diode laser does have limitations in that the quartz fiber is unable to navigate beyond the curvatures of the roots and if it is wedged aggressively into the canal the fiber may prematurely separate and become extremely difficult to navigate past or remove. (5)

A prior concern with using the diode laser in the provision of endodontics was the potential of an increase in temperature intracanal and how that may affect periodontal cells. Gutknecht and his group have cited that the safe temperature threshold for applying the diode laser in the canal is around 7 degrees Celsius increase (6). They looked at various settings and discovered that with Continuous Wave settings a 5 second irradiation and 5 second rest period avoided a temperature increase above the threshold of 7 degrees C). Pulsed settings beyond 20 ms pulse duration and 20 millisecond pulse interval duration were equally effective at mitigating temperature increases (comfort mode on the Picasso Lite is 30 ms duration and interval). Other studies have also shown that using the diode laser can be safely used in the canal without fear of generating too high an increase in intracanal temperature (7-8). **The author's suggestion is to not exceed 1w CW as a maximum when using a 200 micron fiber which can be provide higher energy densities. When using a 400 micron fiber (size #40) higher settings can be used such as 2 watts pulsed (30ms duration and interval) as maximums with water or NaOCL in the canal during irradiation to act as a heat sink if needed.** Time should be limited to 20 seconds duration with a cooling interval and re irrigation between laser irradiation cycles. (9) Two recent studies by Hmud (10-11) have shown that higher diode laser energy settings than those listed above can provide additional benefits of inducing cavitation in water-base media by the formation and implosion of water vapor. Optimal laser-initiated cavitation occurred when weak (3%) peroxide solutions were used as the target irrigant, rather than water. These higher settings could raise the water temperature in the canal by as much as 30 degrees Celsius, but the external root surface temperature was limited to less than a 4 degree Celsius increase. The suggested time for these higher settings was listed as 5 seconds per irradiation. Until further evidence is published the author would strongly suggest controlling the settings to those listed above and applying the laser irradiation for 20 seconds per cycle or less with water or irrigant in the canal.

The diode laser when used in the canals has been shown by SEM images to cause fusion and re-solidification of the dentin surface, with partial removal of debris on the specimens irradiated with the diode laser, compared with controls. The morphologic changes in dentin walls caused by the diode laser's irradiation could improve apical seals and cleanliness. (12-13).

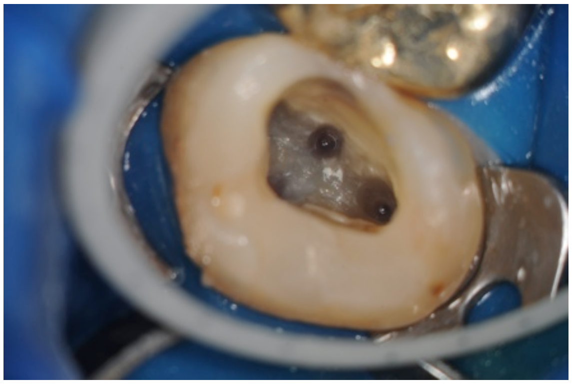
Protocol Diode Laser Bacterial Reduction.

When using the diode laser as an adjunct to the provision of endodontics (root canal therapy) the author proceeds with traditional methods of anesthetic, rubber dam isolation, initial exploration and endodontic access. Mechanical instrumentation through traditional means of hand files and rotary instrumentation allow for irrigants such as EDTA 17%, and NaOCL (5%) to be used to chemically reduce bacterial counts within the complexities of the root canal system.

It is after completion of these steps and immediately before obturation that the author will bring over the diode laser for augmenting the above protocol. The author finds laser disinfection to be valuable particularly in those situations where the pulp is necrotic in nature, or where re-treatment due to a previously unsuccessful endodontic therapy is being undertaken. The protocol is listed below. (Table 1). In addition with straight forward incisor endodontics, sometimes the instrumentation procedure can be completed before the irrigant has had much time to digest tissue and be antibacterial. It is in these cases where the laser can also be very effective in quickly reducing bacterial counts in the single large canal.

Item	Diode Laser Bacterial Reduction (Intracanal)
1	After traditionally instrumenting and cleaning the canals using traditional methods the laser bacterial reduction procedure is done.
2	Select disposable 200 micron strippable fiber for smaller canals (size #20) or disposable 400 micron strippable fiber for larger canals (size #40). Note Disposable tips are usually not long enough to reach the apex.
3	**Do NOT initiate the tip**, as the laser energy exit from the tip. Antibacterial qualities of the laser are desired.
4	Fill canal with water or NaOCL
5	Set the laser to **1.0 W CW (this is the maximum energy for the 200 micron fiber).**
6	Take the working length of the **straight part of the canal** and subtract 1-2 mm from the final total and mark this distance with a rubber stopper. Remember **DO NOT WEDGE THE FIBER INTO THE CANAL AND DO NOT ATTEMPT TO NEGOTIATE ANY CURVATURES WITH THE DIODE FIBER.**
7	Move the laser from an apical point to the coronal part of the tooth (pulp chamber) moving up and down and in a circular fashion 1-2mm per second for a maximum of 20-30 seconds per canal.
8	Obturate the tooth with traditional methods.

Clinical Case



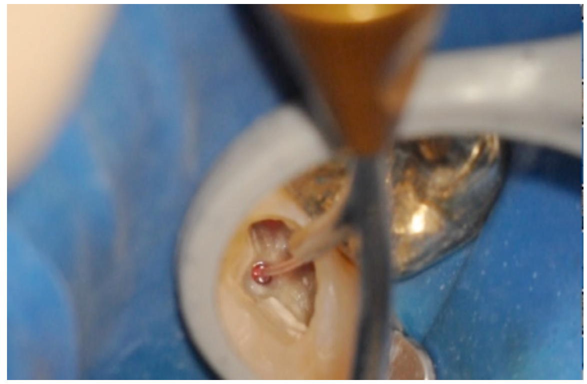
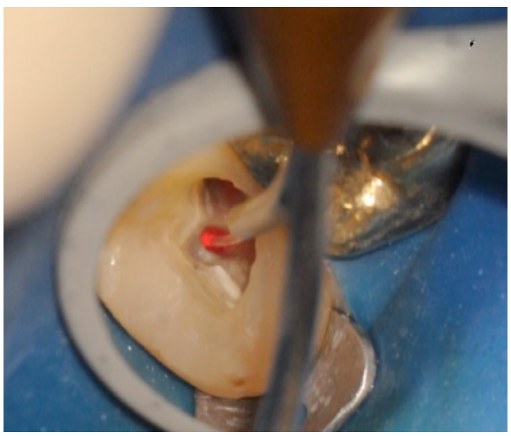


Fig. 1 Four canal upper second molar prior to obturation.
FIg. 2 400 micron diode fiber in DB canal for bacterial reduction.



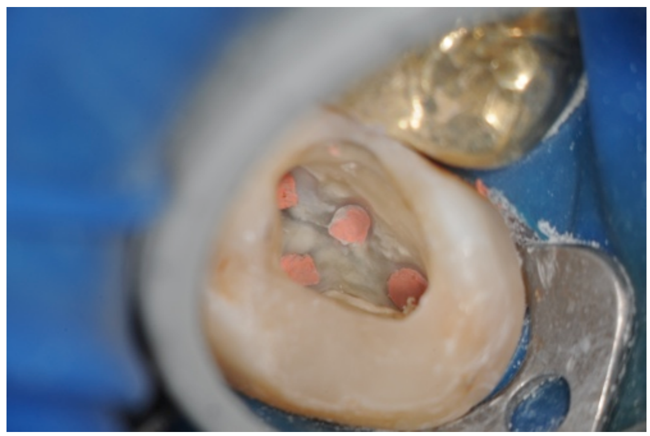


Fig. 3 Diode laser for bacterial reduction in canal.
Fig. 4 Final view of obturated four canals in second molar

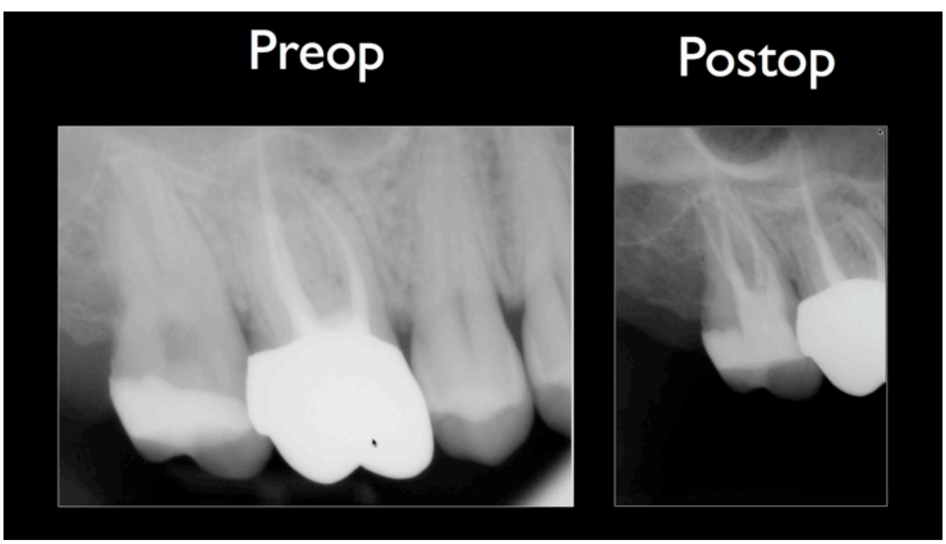


Fig. 5 Preoperative and postoperative radiographs of above case.

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