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ABSTRACT

Objective: To compare the efficacy of root canal cleanliness with and without Nd:YAP laser and to assess the effect of the laser on the mineral content of the dentin. Background Data: A high degree of cleanliness of the canal when using Nd:YAG laser has been shown while the laser had been in contact with the canal wall. A new Nd:YAP laser has been studied recently, which is considered to be superior to Nd:YAG with regard to antibacterial ability due to its 1.34-µ wavelength, which is in the infra red range. This wavelength is absorbed better in water that of Nd:YAG. Materials and Methods: Fourteen extracted single rooted premolars were divided into two groups. In group 1, canals were cleaned, instrumented and shaped with K files. In group 2, initial preparation was done using K files and completed with a Nd:YAP laser. Teeth were then split longitudinally and submitted to SEM. Results: The cleanliness of the laser treated teeth was significantly greater than teeth treated with K files alone (p < 0.05). No difference in Ca and P content was detected when the use of K files was compared to the use of laser. Conclusions: It appears that Nd:YAP laser improves the cleanliness of the root canal. However, since Nd:YAP laser serves as an addition to K files, its clinical value for replacing conventional root canal instrumentation remains to be determined.

INTRODUCTION

LASER TECHNOLOGY has been introduced recently to endodontal therapy. Laser activity is based on the fact that when a light hits a target material, the photon energy is absorbed causing electrons in the atom to increase energy levels and transform to a stimulated state. This state is unstable, and the atom quickly returns to its previous stable state by releasing the embedded in a form of photons. This process is known as spontaneous emission. The principle of laser is to stimulate the atom prior to releasing the photon spontaneously. A chain of photons is created, resulting in a strong monochromatic light beam (same wavelength), in a unified phase.

The effects of laser on hard tissues (enamel, dentin and bone) may occur as chemical, thermal or mechanical changes:

a. Chemical: A change in the chemical and physical properties of the tissue (i.e., desintegration of molecules)
b. Thermal: According to the heat created in the tissue, hyperthermia occurs at 45°C. Dryness, protein denaturation, and coagulation occur between 45°C to 65°C, water vaporization from tissue in 100°C, and desintegration when temperatures exceed 200°C.
c. Mechanical: Hard tissue submitted to high energy beam may undergo plasmatic changes where shock waves cause a destruction of the surrounding tissues.

With regard to root canal treatments, several studies have been published addressing topics such as cleaning and sterilization of the canal as well as apical seal. 1-6 It has been shown that while using both K files and Nd:YAG laser, a funnel canal shape was achieved. 4 Only this laser significantly removed the debris and smear layer from the canal walls. This was explained by the plasma effect of the laser, which turned the surface area of the dentinal wall into ionized gas which later evaporized leaving no remnants on the canal walls. Another study reported that the Nd:YAG laser did not completely remove the debris from canal walls that were prepared using K files.

However, removal of pulp remnants from the coronal thirds of the canals that had not been instrumented previously was observed. 5 The use of Argon laser as an adjunct to file preparation has been found to improve the level of cleanliness of the

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canals. In this study, no melting of the dentin was observed, a finding so prevalent after using other types of laser. Another study confirmed the high degree of cleanliness of the canal when using Nd:YAG laser; however, the author emphasized that the laser should be in contact with the canal wall. This study pointed out the adverse effects of the laser such as cracks in the canal walls. Also, this author questioned the advantage of removing the smear layer from the dentinal walls. When the effect of Nd:YAG laser was compared to root canal conventional irrigation it was found that the laser was inferior to the commonly used 5.25% sodium hypochlorite.

One major concern during treatment laser is the elevated temperature of the tissue surrounding the working area. Such elevation has been observed, but was found to be insignificant to the tissues.

A new Nd:YAP laser has been studied recently. This laser is considered to be superior to Nd:YAG for both temperature elevation and antibacterial ability due to its 1.34-μ wavelength, which is in the infrared range. This wavelength is absorbed better in water that of Nd:YAG.

The purpose of this in vitro study was to compare the efficacy of root canal cleaning and shaping with and without Nd:YAP laser, and to assess the effect of the laser on the mineral composition of the dentin.

MATERIALS AND METHODS

Fourteen extracted single rooted premolars were divided randomly into two groups. In one group, the canals were cleaned, instrumented and shaped with K files to no. 35 at working length. In the other group initial preparation was done with K files up to no. 20, followed by Nd:YAP laser beam (Loki D Dt., France), delivered through a 200-μm-diameter optical fiber which was introduced into the canals.

The first step of canal preparation in this group, was completed when file no. 20 moved freely along the canal and the 200-μm optical fiber has reached the working length. Energy level used was 260 mJ (millijoule) in 5-Hz pulse repetition rate. The fiber was passively introduced into the canal in a circumferential brushing movement to the orifice. The canal was further instrumented with K files to no. 35. A 320-μm optical fiber was then introduced, and the canal was lased as with a 200-μm optical fiber.

During instrumentation of both groups, the canal was irrigated with 2.5% sodium hypochlorite.

After preparation, the teeth in both groups were split longitudinally into two halves using an E1 high-speed bur.

Specimens were covered with a 200A layer of carbon and examined with scanning electron microscope (SEM) and spectrometer 35M-840A (AN 10,000 link analytical). This procedure allows study of the mineral content of the surface. The method is based on bouncing the specimen with a beam of high-voltage electrons, which is returned in different energy level from each mineral. The change in the returned energy from the specimen reflects the change in the mineral content of the specimen.

Micrographs from the coronal, middle, and apical thirds of the canals were taken and examined independently by three dentists not involved in the study. The cleanliness levels were scored from 1 to 3 in the following manner: 1, no debris (clean canal); 2, up to 50% of the canal surface was covered with debris and smear layer; 3, more than 50% of the canal surface was covered with debris and smear layer.

Calcium and phosphorous levels of each specimen were also recorded and the mineral content was expressed as a weight percent.

Three areas along the root canals were compared in each group for the cleanliness of the canals. Then, the average for each tooth was calculated, and compared for the two groups. Wilcoxon test was used for these comparisons.

Student t-test was used for comparison of the mineral content between both groups.

RESULTS

Table 1 shows the mean scores of cleanliness of the root canals after using K files with and without laser treatment. In general, the canals appeared cleaner after using the laser in the coronal, middle and apical thirds. These differences were significant in the coronal and apical thirds.

In the canals treated with K files and in those treated with K files and laser, the coronal third demonstrated maximum cleanliness followed by the middle and apical portions. However these differences were significant only in the teeth treated with laser.

Table 2 shows the calcium (Ca) and phosphorous (P) levels of the coronal, middle, and apical thirds of the root canals treated with and without laser. No difference in the content of Ca and P was detected when the use of K files was compared to the use of laser.

DISCUSSION

Cleaning and biomechanical preparation are crucial steps in performing a root canal treatment. The results of our study show that the use of laser improves the cleanliness of the coronal, middle and apical thirds of the canals. The least clean area was the apical third in both groups. This is in agreement with previous findings. The presence of tissue remnants in the apical third may be explained by the difficulty in viewing that part of the canal compared to the coronal area, and was demonstrated in previous studies. Also, the laser beam is active in the edge only, therefore in order to properly clean the deepest walls of the canal some rotation of the edge is required, a maneuver which is difficult to achieve due to small canal dimensions.
Nd:YAP Laser in Endodontic Therapy

Table 2. Calcium (Ca) and Phosphorous (P) Levels for the Coronal, Middle, and Apical Thirds of the Root Canals Treated with and without Laser

<table>
<thead>
<tr>
<th></th>
<th>K Files</th>
<th>Laser</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Coronal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>33.99 ± 4.18</td>
<td>31.03 ± 3.40</td>
</tr>
<tr>
<td>P</td>
<td>14.36 ± 2.99</td>
<td>15.86 ± 1.46</td>
</tr>
<tr>
<td><strong>Middle</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>33.79 ± 2.61</td>
<td>33.56 ± 1.74</td>
</tr>
<tr>
<td>P</td>
<td>15.99 ± 1.12</td>
<td>15.50 ± 1.43</td>
</tr>
<tr>
<td><strong>Apical</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>35.62 ± 4.63</td>
<td>35.31 ± 1.63</td>
</tr>
<tr>
<td>P</td>
<td>15.78 ± 1.11</td>
<td>15.40 ± 0.70</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>34.47 ± 3.80</td>
<td>32.64 ± 2.56</td>
</tr>
<tr>
<td>P</td>
<td>15.38 ± 1.90</td>
<td>15.41 ± 1.18</td>
</tr>
</tbody>
</table>

Data is expressed as weight percentage.

The cleanest area was found to be the coronal third with the laser and with the K files. This finding is not in agreement with the previous report which demonstrated the cleanest areas to be the coronal and middle.

Another study found differences in canal cleanliness between laser and files only in the coronal part. We cannot speculate about possible reasons for this difference. The higher level of cleanliness of the canals was found after using the laser may be explained by the way the laser works. It evaporates tissue remnants and transforms them into plasma. This vaporization of the smear layer is somewhat controversial among researchers. Some claim that the smear layer contains microorganisms; thus its removal is a positive effect of the laser. On the other hand, the same study notes the smear layer contributes to decreasing the permeability of the canal walls, and therefore protects against invasion of microorganisms after sealing the canal.

Yet another study showed that the smear layer is responsible for leakage between the canal walls and the filling material. Therefore, removal of this layer increases the success of treatment.

Areas in the dentinal walls where the melting of the dentin is observed leave these surfaces clean, with closed dentinal tubuli, thus the seal is obvious. However, other researchers did not find any decrease in dentin permeability after its melting by the Nd:YAG laser.

Our study did not show any change in mineral content of the dentin following the use of laser as compared to the use of K files. This finding is not in agreement with previous findings, which showed a significant decrease in phosphorus following the use of XeCl 308-nm excimer laser. This study also demonstrated a decrease in calcium and an increase in potassium and sulphur levels; however, these changes were not statistically significant. We speculate that the changes in mineral content were attributed to the effect of the laser on the inorganic components of the hydroxyapatite crystals following the melting and recrystallization in the surface of the dentin.

CONCLUSION

In conclusion, it appears that Nd:YAP laser improves the overall cleanliness of the root canal. However, since Nd:YAP laser serves as an addition to K files, its clinical value for replacing conventional root canal instrumentation remains to be determined.

REFERENCES


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