The first documented use of the Er:YAG laser to remove carious tissue and prepare cavities was at the end of the 1980s in a study by Hibst and Keller. Since this type of laser was approved by the US Food and Drug Administration in 1997 for use on hard tissues, an increasing number of studies have investigated the ablation capacity of the Er:YAG laser on both carious and noncarious tissues, showing little evidence of thermal damage to the adjacent tissues. Reported advantages of Er:YAG laser use include no need for local anesthesia, little discomfort during the cavity preparation, and increased resistance of lased enamel to acid attack.

Before the advent of adhesive techniques, cavities were prepared with converging walls, precision line angles, and flat cavity floors. Today, cavity preparations tend to be smaller and have rounded angles. The aim of this study was to evaluate the characteristics of the cavity angles produced by an Er:YAG laser in primary teeth.

Cavosurface Angle Patterns of Er:YAG Laser Cavity Preparations in Primary Teeth

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Purpose: This study assessed cavities prepared in the enamel of primary teeth using Er:YAG laser. The rounding of the cavosurface margins and the angles of concavity at the base of the cuts were evaluated.

Materials and Methods: Twelve exfoliated primary teeth were irradiated with Er:YAG laser emitting a wave length of 2.94 µm with a spot size of 0.70 mm. Radiation was perpendicularly applied for 10 s at a focal distance of 13 mm, with a pulse repetition rate of 10 Hz. The energy was set at either 200 mJ or 300 mJ. Cross-sectional views of the cut surfaces were examined in SEM micrographs (50X). All measurements of cavosurface angles and the angle of concavity were made using a modified cephalometric program.

Results: The t-test analysis indicated differences in the occlusal and cervical cavosurface angles when the energy was modified: increased energy produced a cavity angle reduction. The occlusal vs cervical angle analysis showed no significant difference in cavities prepared with either energy level.

Conclusion: Within the parameters of the present study, we concluded that there was a reduction in the concavity angle of the cavities when the laser energy was increased. The occlusal and cervical cavosurface angles were significantly different when the energy was increased.

Key words: lasers, dental cavity preparation, primary teeth, Er:YAG laser irradiation, scanning electron microscopy, enamel.
MATERIALS AND METHODS

Twelve exfoliated primary molars were used in the present study. These teeth were stored in a solution of saline and 1% thymol prior to testing. The coronal portion of the teeth was embedded in cylindrical acrylic resin blocks (Ortocryl, Ortoclass, São Paulo, Brazil), but their labial surfaces were left exposed (Fig 1). The teeth were divided into two equal groups. In both groups, laser was applied perpendicular to the middle part of the labial surface of the crown for 10 s at a frequency of 10 Hz and a distance of 13 mm between the tooth surface and the laser beam (Fig 2). However, the energy applied to group 1 samples was 200 mJ, and to group 2 samples 300 mJ. The laser used was the Er:YAG Twinlight Laser, Model S (Fotona Medical Lasers, Ljubljana, Slovenia), which has a wavelength of 2.94 µm. It is equipped with an articulated arm and is cooled by water spray. Its ideal focal distance is between 12 and 15 mm, and it has a spot size of 0.70 mm. After irradiation, each sample was cut in half in a cervical-occlusal direction with a slow-speed diamond blade (Isomet 1000, Buehler, Lake Bluff, IL, USA). Samples were prepared for scanning electron microscopic examination (JEOL, JSM-LL 3330A, 20 KV, Tokyo, Japan), and scanning electron micrographs (50X) of the cavities were examined. A special piece of paper used for cephalometric drafts was fixed above each micrograph, and lines and points selected in the cavity preparation were traced onto this piece of paper (corresponding to the labial surface of the tooth, the distal and medial walls, and the deepest point of the cavity). The drawings were positioned on a digitizer table (TLP 1212, Kurta, Phoenix, AZ, USA), and the points identified on them were digitized using the software DF Plus 6.5, 1995 (Dentofacial Software, Toronto, Canada) to calculate the occlusal cavosurface angle (OCA), the cervical cavosurface angle (CCA), and the concavity angle (CA) (Fig 3).
The data were transferred to SPSS for Windows 8.0 (SPSS, 1997) to perform the statistical analysis. ANOVA was applied, and the angles OCA and CCA were compared using a paired t-test.

RESULTS

Table 1 reports the means, the standard deviations, and the maximum and minimum values of the angles OCA, CCA, and CA for Group 1 (200 mJ) and Group 2 (300 mJ). A reduction in the concavity angle when energy was increased can be observed.

Table 2 presents a summary of the statistical analysis, showing that the occlusal cavosurface angle, the cervical cavosurface angle, and the concavity angle were significantly different when the energy was increased. Table 3 shows that there were no statistically significant differences between the cervical cavosurface angles and the occlusal cavosurface angles.

DISCUSSION

The shape of the cavities produced by an Er:YAG laser changes in relation to the parameters utilized during irradiation, and whether or not water cooling was employed. Many studies have demonstrated that water cooling is required to reduce the increase in pulpal temperature and to improve the ablation rate during cavity preparation. Another factor to be considered is the composition of the lased tissue, as ablation of permanent tooth tissue is different from that of primary tooth tissue, due to the increased porosity and thus higher water content of primary-tooth enamel.

In this study, the time of irradiation (10 s), the frequency (10 Hz), and the focal distance (13 mm) were constant, but the energy applied varied between the two groups (G1: 200 mJ; G2: 300 mJ). We observed
that an increase of energy reduced the concavity angle. This fact is explained by the increase in the cavity depth produced by the increase of energy. The direct relation between energy and cavity depth is explained by the Gaussian form of the laser beam, as reported by many authors.\textsuperscript{1,16-19} This is a clinically relevant fact, as authors have reported less microleakage when cavity margins are beveled and cavities are V-shaped.\textsuperscript{20-22}

Both the occlusal and the cervical cavosurface angle showed significant differences when the energy was increased. We observed that angle values varied between 117.21 and 161.82 degrees; in other words, they were always greater than 90 degrees. The size of the cavosurface angles in cavities produced by the Er:YAG laser may help reduce microleakage. The microleakage occurring in cavities prepared with Er:YAG laser has been studied. Many studies have reported that microleakage is similar\textsuperscript{26-28} or even increased\textsuperscript{24} compared to other methods of preparation; conversely, other authors suggest that microleakage is reduced.\textsuperscript{5}

When comparing the occlusal and the cervical cavosurface angle, we observed that they were similar, independent of the energy applied. Boston et al\textsuperscript{23} observed a difference in the angulations of occlusal and cervical cavosurface margins prepared with a drill or an air-abrasion system, and attributed this finding to the difference in the enamel prism orientation and enamel composition and thickness in the two different regions of the tooth.

**CONCLUSION**

Given the parameters of the present study, we conclude that the concavity angle of the cavities decreases when the laser energy increases. The occlusal and cervical cavosurface angles were significantly different when the energy was increased. It is essential that the dentist be aware of the alteration produced in the cavity form and cavosurface angles by the variation of energy, to ensure selection of the appropriate laser parameters for the desired cavity preparation.

**REFERENCES**


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