©Operative Dentistry, 2010, **35-5,** 500-507

Clinical Comparison of Bur- and Laser-prepared Minimally Invasive Occlusal Resin Composite Restorations: Two-year Follow-up

AR Yazici • M Baseren • J Gorucu

Clinical Relevance

The laser could be a promising alternative for minimally invasive occlusal resin composite cavity preparations, as its clinical performance was similar to bur-prepared composite restorations.

SUMMARY

This study evaluated the two-year clinical performance of two minimally invasive cavity preparation techniques, bur and laser, in Class I occlusal resin composite restorations.

Twenty-seven patients, each having at least one pair of occlusal caries, were enrolled in this study. For each patient, one of the cavities was prepared with a diamond bur, and the other was prepared with Er, Cr:YSGG laser. The cavities were restored with a nanofilled flowable resin composite, Grandio Flow, using an etch-and-rinse adhesive, Solobond M. A total of 108 restorations were placed in molars by a single operator. The restorations were evaluated according to modified Cvar/Ryge criteria. The evaluations were performed at baseline, 6, 12, 18 and 24 months after initial placement by two calibrated operators. The Chi-square and Fisher's exact test were used for statistical analysis.

All the patients were available during all evaluated periods, resulting in a recall rate of 100%. The retention rates of the restorations at 24

*A Rüya Yazici, DDS, PhD, professor, Hacettepe University, Faculty of Dentistry, Department of Conservative Dentistry, Ankara, Turkey

Meserret Baseren, DDS, PhD, professor, Hacettepe University, Faculty of Dentistry, Department of Conservative Dentistry, Ankara, Turkey

Jale Gorucu, DDS, PhD, professor, Hacettepe University, Faculty of Dentistry, Department of Conservative Dentistry, Ankara, Turkey

*Reprint request: 06100, Sihhiye, Ankara, Turkey; e-mail: ruyay@hacettepe.edu.tr

DOI: 10.2341/09-339-C

months were 98.1% for bur and 100% for the laser-prepared group. After 24 months, 5.6% of the bur-prepared and 7.4% of the laser-prepared restorations were rated Bravo in marginal discoloration ($p>0.05$). Bur-prepared (9.3%) and laser-prepared (13%) restorations were rated Bravo in marginal adaptation ($p>0.05$). There were no significant differences between the two cavity preparation techniques regarding the evaluated parameters ($p>0.05$).

Both cavity preparation techniques performed equally, with excellent outcomes after a 24-month period.

INTRODUCTION

Minimal invasive dentistry has gained popularity with the development of new adhesive systems and technological improvements in cutting tools for tooth preparation. The concept of "extension of prevention" has, as much as possible, left its mark on the preservation of sound tooth structure. Moreover, adhesive dental materials make it possible to conserve tooth structure using minimally invasive cavity preparations by minimizing the requirement for retention and resistance form. The preservation of original tissue is known to enhance the prognosis of the tooth. This new concept has become the guiding factor in cavity preparation.[1] Therefore, alternative methods, such as air abrasion, sono-abrasion and lasers, have been suggested for cavity preparation.

Lasers have been used in dentistry for more than 20 years. However, the use of Erbium lasers has recently received a great deal of attention, with the trend moving towards minimum intervention dentistry, as it offers an alternative to conventional bur preparation with minimal tissue loss.[2-4] The Erbium: Yttrium-Aluminum Garnet (Erbium:YAG) and Erbium Chromium:Yttrium-Scandium-Gallium-Garnet (Er,Cr:YSGG) lasers present several advantages. These lasers emit energy in the wavelength of 2.94 μm and 2.78 μm, respectively, which coincides with the absorption peak of water and is well absorbed by all biological tissues, including enamel and dentin.[5] Once light from the laser is absorbed, it is converted to heat. The overheated water vaporizes and causes micro-explosions that carry away surrounding tooth fragments.[6] Thereby, they have several hard tissue applications, such as enamel and dentin etching, caries removal and cavity preparation.[2,7-11]

One aspect of patient discomfort frequently noted during treatment with rotary instruments is bone-conducted noise and vibration.[12] Local anesthetic is frequently required, which is another aspect of dental treatment that renders patients particularly anxious.[13] These factors are eliminated and local anesthesia is rarely needed during laser treatment,[14] making the procedure more comfortable for patients.[15]

The morphology and nature of the prepared tooth surface influences bonding of the adhesive restorative materials that are used to restore the tooth; therefore, prolonging the clinical longevity of restorations. It has been reported that laser irradiated surfaces show a rough, clean surface without the smear layer, with exposed enamel rods and opened dentin tubules.[16-17] Therefore, it is reasonable to suppose that these morphologic patterns might be more favorable for the adhesion of restorative materials, far more than bur-prepared cavities that are covered by a smear layer.[18-19] Smear layer removal or modification is essential for the formation of a high quality hybrid layer and, thus, optimal adhesion to dentin.[20] Although a variety of *in vitro* studies of the effects of lasers have been reported, the marginal adaptation and bond strength of laser-prepared tooth structure is still a controversial issue in the literature. Several authors have reported lower bonding effectiveness for laser-treated surfaces;[21-24] whereas, other authors found similar results compared to bur-cut surfaces.[25-26] On the other hand, laboratory results can never completely simulate the complex oral environment. To validate *in vitro* studies, clinical studies need to be performed. To the best knowledge of the authors of the current study, no clinical study has been conducted that compares the longevity of restorations placed in laser and bur-prepared cavities.

The current study compared the clinical performance of bur- and laser-prepared minimally invasive Class I occlusal resin composite restorations.

METHODS AND MATERIALS

Selection Criteria

A protocol and consent form for the current study were reviewed and approved by the Ethics Committee of Hacettepe University. Written informed consent was obtained from all participants.

Twenty-seven subjects (21 female, 6 male), ranging in age from 19 to 21 years who had been diagnosed with at least two active occlusal non-cavitated superficial carious lesions in first and second permanent molars having antagonist natural teeth, were included in the study. Exclusion criteria were the presence of frank occlusal cavitation, poor oral hygiene, serious systemic diseases and bruxism.

Caries lesions in the selected sites were assessed by visual inspection, a laser fluorescence device (DIAGNOdent, Kavo, Biberach, Germany) and bite-wing radiography. Visual inspections were performed with patients positioned in a dental chair with reflector light, air/water spray and a plane buccal mirror using the visual-ranked method developed by

Ekstrand and others[27] under standardized conditions. All lesions were recorded with the aid of a dental loop (2.5x, Heine Optotechnik, Herrsching, Germany). Each occlusal surface was examined using tip A of the DIAGNOdent laser fluorescence device. The tip was placed perpendicular on the preselected occlusal site and rotated, with the maximum reading (peak value) recorded. The peak value was then correlated with the definitions of a scale that corresponded to the absence or presence of a carious lesion. Three measurements were performed and the mean reading was recorded. The teeth with DIAGNOdent readings between 14 and 29 were selected. Bitewing radiographs were taken for each tooth using standard intra-oral film (Kodak Ekta Speed, Eastman Kodak Co, Rochester, NY, USA) with a 60 kVp X-ray machine. The radiographs were developed consecutively using an automatic processor, and they were assessed using a standard radiographic illuminated viewing box at a magnification of 2x. All the examinations were performed independently on the same day by two clinicians who were calibrated before starting the study. The Kappa index obtained was 0.75 for the visual examination, 0.71 for the DIAGNOdent measurements and 0.91 for radiography, suggesting high inter-examiner consistency. Then, a decision was made regarding treating the tooth using minimally invasive techniques.

Restorative Procedures

The teeth to be restored were first cleaned with a slurry of plain pumice and water to remove the salivary pellicle and any remaining dental plaque. Isolation was accomplished using cotton rolls. The teeth were randomly assigned to cavity preparation techniques: group I–bur and group II–laser. Each patient received at least two cavities: one was prepared by bur and the other by laser. Distribution of the cavity preparation techniques per tooth was done using a table of random numbers.

Group I: Class I occlusal cavities were prepared using a high-speed diamond bur (835/010-4ML, Diatech Dental AG, Heerbrugg, Switzerland) under constant water cooling.

Group II: Class I occlusal cavities were prepared using an Er,Cr:YSGG laser (Waterlase MD, Biolase World Headquarters, Irvine, CA, USA) emitting photons at a wavelength of 2780 nm. Laser energy was delivered through a sapphire tip, 600 µm in diameter and 6-mm long, bathed in an adjustable air and water vapor. The angulation of the tip was perpendicular to the enamel prisms. The enamel laser irradiation was performed using a focus mode to remove enamel at a setting of 5.5 W, 20 Hz (275mj) with 70% water and 80% air. The pulse duration was 140 µ seconds. The setting was reduced to 4 W, 20 Hz on dentin with 70% water and 80% air.

The buccolingual width of each preparation was not greater than one-third the distance between the cusp tips as measured with a periodontal probe. No additional "extension for prevention" and no visible preparation of undercuts was performed after the lesions were completely excavated, if needed. Visual and tactile feedback from an explorer was used to determine the end of caries removal. The enamel was etched for 30 seconds and the dentin for 15 seconds with a 34.5% phosphoric acid etchant (Vocovid, Voco GmbH, Cuxhaven, Germany), then rinsed for 20 seconds with an air-water spray and dried, leaving the dentin slightly moist. The adhesive system, Solobond M (Voco GmbH), was applied to prepared cavities according to the manufacturer's directions. After adhesive curing, all cavities were restored using a nanofilled flowable resin composite, Grandio Flow (Voco GmbH), which was placed in one increment (Table 1). The resin was light-cured for 40 seconds using a halogen light curing unit (Hilux, Benlioglu, Ankara, Turkey) with an output not less than 550mW/cm^2. No liners or bases were placed. After checking occlusion, finishing was accomplished using contouring and finishing diamond burs (Diatech, Switzerland) at high speed, and polishing was done with polishing discs (Sof-Lex, 3M ESPE, St Paul, MN, USA) and rubber points at low speed under constant water cooling. All the procedures were performed without local anesthesia. All the restorations were done by the same operator (JG) with cotton roll isolation and a chairside assistant.

At least two restorations were placed in each patient, resulting in a total of 108 restorations. Of the 54 bur-prepared restorations, 31 were placed in upper molars and 23 in lower molars. In laser-prepared cavities, 25 restorations were placed in upper and 29 in lower molars.

Clinical Evaluation Criteria

The restorations were clinically evaluated at baseline, 6, 12, 18 and 24 months using modified Cvar/Ryge criteria (Table 2). For each criteria, Alpha was used to indicate the highest degree of clinical acceptability, Bravo scores represented clinically acceptable scores, while a Charlie score meant a clinically unacceptable score. Evaluation was done by two other independent investigators not involved with the treatment procedures using a mirror, explorer and air stream. The investigators were calibrated to a predetermined level of inter- and intra-examiner agreement at least 95% per single criteria. Any discrepancy between evaluators was resolved at chairside.

Statistical Analyses

The Chi-square and Fisher's exact test were used to compare the two cavity preparation techniques in the same recall period for each of the criteria at the 5% level of significance. The Cochran Q-test was used to

Table 1: *Material, Batch, Composition and Mode of Application of Materials*

Material	Composition	Mode of Application
Solo Bond M (etch-and-rinse adhesive) (Voco, Cuxhaven, Germany) Batch #550440	Bis-GMA, HEMA, BHT, acetone, organic acids	Acid etching-34.5% phosphoric acid (30 seconds), rinsing (30 seconds), gently air dry leaving dentin moist (15 seconds), adhesive application, light-curing (20 seconds)
Grandio Flow (flowable resin composite) (Voco, Cuxhaven, Germany) Batch #602198	Inorganic fillers, Bis-GMA, TEGDMA, HEDMA	Application of resin composite, light cure (40 seconds)

Abbreviations: Bis-GMA: bis-phenol A diglycidylmethacrylate; HEMA: 2-hydroxyethyl methacrylate; BHT: butylated hydroxytoluene TEGDMA: triethyleneglycodimethacrylate; HEDMA:hexandioledimethacrylate

examine changes across the four time points for each of the criteria. Pairwise comparison was performed using the McNemar test. The statistical analyses were carried out with the SPSS 16.0 software package (SPSS, Chicago, IL, USA).

RESULTS

After 24 months, all patients were available at all the evaluated periods, resulting in a recall rate of 100%. The retention rates of the baseline and re-evaluation after 6 months, 12, 18 and 24 months are shown in Table 3. None of the laser-prepared restorations were lost during the two-year study period, resulting in an excellent retention rate of 100%. Only one restoration was lost in the bur group at two years, resulting in a retention rate of 98.1%. No significant differences in retention rate were observed between the two groups (p=0.500).

For marginal discoloration, one restoration from the laser-prepared group rated Bravo after 12 months, and no differences were observed between the two cavity preparation techniques (p=0.500). After 18 months, two more restorations, and at the end of 24 months, a total of four restorations rated Bravo in the laser group. Only three restorations from the bur group

Table 2: *Modified Cvar/Ryge Criteria*

Retention	**Alpha:** The restoration is present **Charlie:** The restoration is absent
Marginal Discoloration	**Alpha:** There is no visual evidence of marginal discoloration different from the color of the restorative material and from the color of the adjacent tooth structure **Bravo:** There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration that has not penetrated along the restoration in a pulpal direction **Charlie:** There is visual evidence of marginal discoloration at the junction of the tooth structure and the restoration with the discoloration has penetrated along the restoration in a pulpal direction
Marginal Adaptation	**Alpha:** Restoration is closely adapted to the tooth. The explorer does not catch when drawn across the surface of the restoration toward tooth structure or if the explorer does catch there is no visible crevice along the periphery of the restoration **Bravo:** The explorer catches and there is visible evidence of a crevice which the explorer penetrates, indicating that the edge of the restoration does not adapt closely to the tooth structre. The dentin and/or the base are not exposed and the restoration is not mobile **Charlie:** The explorer penetrates a crevice defect which extends to the dentino-enamel juction
Anatomic Form	**Alpha:** Restoration is continuous with the existing anatomic form **Bravo:** Restoration is discontinuous with the existing anatomic form but is missing material that is not sufficient to expose dentin or the base **Charlie:** Sufficient material is lost to expose dentin or base
Surface Texture	**Alpha:** Surface texture is similar to polished enamel as determined by means of a sharp explorer **Bravo:** Surface texture s gritty or similar to to a surface subject to a white stone or rougher than the adjacent tooth structure **Charlie:** Surface pitting is sufficiently coarse to inhibit the continuous movement of an explorer across the surface
Color Match	**Alpha:** Restoration matches the shade and translucency of adjacent tooth structure **Bravo:** Restoration does not match the shade and translucency of adjacent tooth structure but the mismatch is within the normal range of tooth shades **Charlie:** Restoration does not match the shade and translucency of adjacent tooth structure and the mismatch is out side the normal range of tooth shades and translucency
Postoperative Sensitivity	**Alpha:** None **Bravo:** Mild, but bearable **Charlie:** Present
Secondary Caries	**Alpha:** No caries present **Charlie:** Caries present

Table 3: *Results of Clinical Evaluation*

		Retention			Marginal Discoloration			Marginal Adaptation			Anatomic Form			Surface Texture			Color Match			Postop Sensitivity		
BUR	**n**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Baseline	54	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
6m	54	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
12m	54	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	52 (96.3%)	2 (3.7%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (100%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
18m	54	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	50 (92.6%)	4 (7.4%)	0 (0%)	52 (96.3%)	2 (3.7%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
24m	54	53 (98.1%)	0 (0%)	1 (1.9%)	51 (94.4%)	3 (5.6%)	0 (0%)	49 (90.7%)	5 (9.3%)	0 (0%)	51 (94.4%)	3 (5.6%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
LASER	**n**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
Baseline	54	54 100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
6m	54	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
12m	54	54 (100%)	0 (0%)	0 (0%)	53 (98.1%)	1 (1.9%)	0 (0%)	52 (96.3%)	2 (3.7%)	0 (0%)	52 (96.3%)	2 (3.7%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
18m	54	54 (100%)	0 (0%)	0 (0%)	51 (94.4%)	3 (5.6%)	0 (0%)	49 (90.7%)	5 (9.3%)	0 (0%)	52 (96.3%)	2 (3.7%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)
24m	54	54 (100%)	0 (0%)	0 (0%)	50 (92.6%)	4 (7.4%)	0 (0%)	47 (87%)	7 (13%)	0 (0%)	51 (94.4%)	3 (5.6%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)	54 (100%)	0 (0%)	0 (0%)

A:Alpha, B: Bravo, C: Charlie

rated Bravo at the 24-month recall. There were no statistical differences between the two groups at the 18- (p=0.121) and 24-month recall (p=0.500). For both groups, no deep generalized discoloration was detected. Differences in marginal discoloration ratings between each evaluation period were found to be statistically significant for both groups (p=0.017).

In terms of marginal adaptation, two restorations from the laser and two from the bur group rated Bravo at 12 months (p=0.691). No severe margin defects were recorded for both groups either at 18 months (p=0.500) or at the two-year recall (p=0.759). Regarding the marginal adaptation scores in the laser group, differences among all evaluation periods were not statistically significant except for ratings between baseline and 24 months (p=0.016) and 6 months vs 24 months (p=0.016).

With regards to anatomic form, both groups were virtually the same, with 96.3% of the restorations having no anatomic form loss at 18 months (p=0.691) and 94.4% having no anatomic form loss at the end of 24 months (p=0.661). According to the Cochran Q test, statistical differences were found between each evaluation period for the bur group (p=0.040) and no differences were observed in the laser cavity preparation group (p=0.061).

Surface texture and color match was scored as Alpha for all restorations. No secondary caries was detected in association with any restoration after two years in both groups tested. Postoperative sensitivity was absent in all patients. No statistically significant differences were found among the cavity preparation groups in any of the evaluation criteria at all recalls (p>0.05).

DISCUSSION

In light of minimally invasive dentistry, laser technology offers an interesting alternative to the conventional use of diamond burs. In the current clinical study, bur- and laser-prepared occlusal composite restorations were compared and both demonstrated good results. No restorations were lost at 6, 12 and 18 months. As only one restoration from the bur group was lost at the 24-month recall, both groups fulfilled the American Dental Association (ADA) retention criteria.[28] After two years, the retention rate was 100% for the laser-prepared and 98.1% for the bur-prepared group, thereby satisfying the full acceptance guidelines specified by the ADA.

Laboratory research can predict the clinical performance of different cavity preparation techniques to a certain extent; however, clinical trials provide better information, and these studies are always needed to confirm these results. Proper comparisons are unavailable due to a lack of studies evaluating the clinical performance of resin composite restorations that are prepared with Er,Cr:YSGG laser.

It might have been expected that the retention rates would be different, since the design and surface finish of the cavity preparation produced by laser differed from that achieved by conventional bur preparation. The morphologic alterations caused by laser irradiation might affect the bond strength of restorative resins.[19,22] Many studies assessing the bond strength of resin composites to laser-prepared tooth structures have been conducted.[21-26] While a decrease in the bond strength of laser-treated surfaces compared with bur-cut preparations was shown,[16,21-23,29-30] some reported no difference.[25-26] These contradictory findings might vary

according to the type of laser and the parameters used for cavity preparation.

The microleakage rate for each cavity preparation technique was below the 5% level of ADA requirement for provisional acceptance after six months of clinical service. None of the restorations in the bur group showed discoloration until the 24-month recall and only 1.9% of the laser group had superficial discoloration at 12 months, 5.6% at 18 months and 7.4% at 24-months. No differences between the restorations performed with bur and laser could be detected with regards to marginal discoloration.

In an *in vitro* microleakage study, laser cavity preparation for Class V cavities resulted in less leakage than cavity preparation with a bur.[31] In another study, cavities prepared by Er:YAG laser were found to be capable of decreasing the microleakage of resin composite restorations, and their efficiency was similar to etched bur cavities.[32] Moldes and others[33] compared the degree of microleakage of composite restorations performed by lasers and those by conventional drills associated with two adhesive systems. The enamel margins demonstrated no differences in microleakage for all treatments. The dentin margins presented similar microleakage in cavities prepared with Er:YAG, Er,Cr:YSGG and drill using the etch-and-rinse two-step adhesive system. Khan and others[34] compared the resin composite restorations placed in laser- and bur-prepared cavities. They did not observe any difference in terms of microleakage.

It has been reported that a scaly, irregular and rugged appearance of dentin was displayed after Er,Cr:YSGG laser irradiation. The absence of smear layer coverings and exposed dentin tubule orifices were also observed.[23] These morphologic features, highly irregular surfaces without a smear layer, seem to be a suitable surface for adhesion. On the other hand, laser irradiation results in collagen fibril fusion and denaturation, closing the interfibriller spaces that might decrease the resin infiltration into the prepared surface and cause inferior adhesion to dentin.

In the current study, no difference was observed between the two cavity preparation methods in terms of marginal discoloration and adaptation. Adjunctive use of acid might cause this result. It has been reported that acid etching of enamel following laser, as a kind of finishing enamel, gave much better results.[35-36] Lee and others[23] found that Er,Cr:YSGG laser irradiation adversely affected the adhesion of resin to dentin but acid etching following laser irradiation might increase bond strength as much as that of bur-cut/acid-etched dentin. In another study, no difference was noted in the microleakage of composite restorations in Class II cavities between laser and bur preparation if Er,Cr:YSGG laser preparation was associated with acid etching.[37] Acid etching following Er,Cr:YSGG laser irradiation could demineralize the inorganic portion of surface dentin and produce a favorable environment for molecular entanglement of polymer chains with collagen fibrils. The widened dentinal tubule orifices might also facilitate the deep infiltration of adhesive.[23]

Several studies have reported secondary caries as the main reason for restoration failure. It has been reported that Er,Cr:YSGG laser irradiation increases resistance to acid demineralization, thus reducing the acid dissolution of dental hard tissues and playing an important role in the prevention of secondary caries.[38]

The nano-filled flowable resin composite, Grandio Flow, was used to restore all cavities. The reason for selecting only one resin composite was to solely obtain a comparison of the cavity preparation techniques, not a system that consisted of adhesive and resin composite. Contour and surface texture presented 100% Alpha and they were unchanged from baseline for all restorations, which is more related to the resin composite used for the restoration. In regards to postoperative sensitivity, none of the patients suffered from pain in either group after two years.

CONCLUSIONS

Both cavity preparation methods (bur and laser) performed well clinically and met the ADA full-acceptance criteria for bonded restorative materials after two years. Therefore, lasers can be stated as being an acceptable technique for minimally-invasive resin composite cavity preparations. However, long-term recalls are planned to determine if differences in clinical performance between bur- and laser-prepared groups will occur at later restoration ages.

(Received 12 November 2009; Accepted 9 April 2010)

References

1. Murdoch-Kinch CA & McLean ME (2003) Minimal invasive dentistry *Journal of the American Dental Association* **134(1)** 87-95.
2. Kornblit R, Trapani D, Bossù M, Muller-Bolla M, Rocca JP & Polimeni A (2008) The use of Erbium: YAG laser for caries removal in paediatric patients following minimally invasive dentistry concepts *European Journal of Paediatric Dentistry* **9(2)** 81-87.
3. Eberhard J, Bode K, Hedderich J & Jepsen S (2008) Cavity size difference after caries removal by a fluorescence-controlled Er:YAG laser and by conventional bur treatment *Clinical Oral Investigations* **12(4)** 311-318.
4. Navarro RS, Gouw-Soares S, Cassoni A, Haypek P, Zezell DM & de Paula Eduardo C (2009) The influence of erbium: yttrium-aluminum-garnet laser ablation with variable pulse width on morphology and microleakage of composite restorations *Lasers in Medical Science* **4** (in press).

5. Fried D, Ashouri N, Breunig T & Shori R (2002) Mechanism of water augmentation during IR laser ablation of dental enamel *Lasers in Surgery and Medicine* **31(3)** 186-193.
6. Hibst R & Keller U (1989) Experimental studies of the application of the Er: YAG laser on dental hard substances: I. Measurement of the ablation rate *Lasers in Surgery and Medicine* **9(4)** 338-344.
7. Hadley J, Young DA, Eversole LR & Gornbein JA (2000) A laser-powered hydrokinetic system for caries removal and cavity preparation *Journal of the American Dental Association* **131(6)** 775-785.
8. Matsumoto K, Hossain M, Hossain MM, Kawano H & Kimura Y (2002) Clinical assessment of Er, Cr: YSGG laser application for cavity preparation *Journal of Clinic Laser Medicine and Surgery* **20(1)** 17-21.
9. Hossain M, Nakamura Y, Yamada Y, Murakami Y & Matsumoto K (2002) Microleakage of composite resin restoration in cavities prepared by Er, Cr: YSGG laser irradiation and etched bur cavities in primary teeth *Journal of Clinical Pediatric Dentistry* **26(3)** 263-268.
10. Hossain JM, Nakamura Y, Yamada Y, Murakami Y & Matsumoto K (2002) Compositional and structural changes of human dentin following caries removal by Er, Cr: YSGG laser irradiation in primary teeth *Journal of Clinical Pediatric Dentistry* **26(4)** 377-382.
11. Cehreli SB, Gungor HC & Karabulut E (2006) Er,Cr:YSGG laser pretreatment of primary teeth for bonded fissure sealant application: A quantitative microleakage study *Journal of Adhesive Dentistry* **8(6)** 381-386.
12. Berggren U & Meynert G (1984) Dental fear and avoidance: Causes, symptoms and consequences *Journal of the American Dental Association* **109(2)** 247-251.
13. Green RM & Green A (1985) Adult attitudes to dentistry among dental attenders in South Wales *British Dental Journal* **159(5)** 157-160.
14. Parkins F(2000) Lasers in pediatric and adolescent dentistry *Dental Clinics of North America* **44(4)** 821-830.
15. Keller U, Hibst R, Geurtsen W, Schilke R, Heidemann D, Klaiber B & Raab WH (1998) Erbium: YAG laser application in caries therapy. Evaluation of patient perception and acceptance *Journal of Dentistry* **26(8)** 649-656.
16. Aranha AC, De Paula Eduardo C, Gutknecht N, Marques MM, Ramalho KM & Apel C (2007) Analysis of the interfacial micromorphology of adhesive systems in cavities prepared with Er, Cr: YSGG, Er:YAG laser and bur *Microscopy Research and Technique* **70(8)** 745-751.
17. Delmé KI & De Moor RJ (2007) Scanning electron microscopic evaluation of enamel and dentin surfaces after Er: YAG laser preparation and laser conditioning *Photomedicine and Laser Surgery* **25(5)** 393-401.
18. Visuri SR, Gilbert JL, Wright DD, Wigdor HA & Walsh JT Jr (1996) Shear strength of composite bonded to Er: YAG laser-prepared dentin *Journal of Dental Research* **75(1)** 599-605.
19. Trajtenberg CP, Pereira PN & Powers JM (2004) Resin bond strength and micromorphology of human teeth prepared with an Er:YAG laser *American Journal of Dentistry* **17(5)** 331-336.
20. Van Meerbeek B, De Munck J,Yoshida Y, Inoue S, Vargas M, Vijay P, Van Landuyt K, Lambrechts P & Vanherle G (2003) Buonocore Memorial Lecture. Adhesion to enamel and dentin: Current status and future challenges *Operative Dentistry* **28(3)** 215-235.
21. De Munck J, Van Meerbeek B, Yudhira R, Lambrechts P & Vanherle G (2002) Micro-tensile bond strength of two adhesives to Erbium: YAG-lased vs bur-cut enamel and dentin *European Journal of Oral Science* **110(4)** 322-329.
22. Dunn WJ, Davis JT & Bush AC (2005) Shear bond strength and SEM evaluation of composite bonded to Er: YAG laser-prepared dentin and enamel *Dental Materials* **21(7)** 616-624.
23. Lee BS, Lin PY, Chen MH, Hsieh TT, Lin CP, Lai JY & Lan WH (2007) Tensile bond strength of Er, Cr: YSGG laser-irradiated human dentin and analysis of dentin-resin interface *Dental Materials* **23(5)** 570-578.
24. Cardoso MV, Coutinho E, Ermis RB, Poitevin A, Van Landuyt K, De Munck J, Carvalho RC, Lambrechts P & Van Meerbeek B (2008) Influence of Er,Cr:YSGG laser treatment on the microtensile bond strength of adhesives to dentin *Journal of Adhesive Dentistry* **10(1)** 25-33.
25. Ergücü Z, Celik EU, Unlü N, Türkün M & Ozer F (2009) Effect of Er,Cr:YSGG laser on the microtensile bond strength of two different adhesives to the sound and caries-affected dentin *Operative Dentistry* **34(4)** 460-466.
26. Chou JC, Chen CC & Ding SJ (2009) Effect of Er,Cr:YSGG laser parameters on shear bond strength and microstructure of dentine *Photomedicine and Laser Surgery* **27(3)** 481-486.
27. Ekstrand KR, Ricketts DN & Kidd EA (1997) Reproducibility and accuracy of three methods for assessment of demineralization depth of the occlusal surface: An *in vitro* examination *Caries Research* **31(3)** 224-231.
28. American Dental Association Council on Scientific Affairs. Acceptance program guidelines: Dentin and enamel adhesive materials Chicago American Dental Association 2001.
29. Esteves-Oliveira M, Zezell DM, Apel C, Turbino ML, Aranha AC, Eduardo Cde P & Gutknecht N (2007) Bond strength of self-etching primer to bur cut, Er,Cr:YSGG, and Er:YAG lased dental surfaces *Photomedicine and Laser Surgery* **25(5)** 373-380.
30. Cardoso MV, De Munck J, Coutinho E, Ermis RB, Van Landuyt K, de Carvalho RC & Van Meerbeek B (2008) Influence of Er,Cr:YSGG laser treatment on microtensile bond strength of adhesives to enamel *Operative Dentistry* **33(4)** 448-455.
31. Shahabi S, Ebrahimpour L & Walsh LJ (2008) Microleakage of composite resin restorations in cervical cavities prepared by Er,Cr:YSGG laser radiation *Australian Dental Journal* **53(2)** 172-175.
32. Hossain M, Yamada Y, Nakamura Y, Murakami Y, Tamaki Y & Matsumoto K (2003) A study on surface roughness and microleakage test in cavities prepared by Er: YAG laser irradiation and etched bur cavities *Lasers in Medical Science* **18(1)** 25-31.
33. Moldes VL, Capp CI, Navarro RS, Matos AB, Youssef MN & Cassoni A (2009) *In vitro* microleakage of composite restorations prepared by Er:YAG/Er,Cr:YSGG lasers and conventional drills associated with two adhesive systems *Journal of Adhesive Dentistry* **11(3)** 221-229.

34. Khan MF, Yonaga K, Kimura Y, Funato A & Matsumoto K (1998) Study of microleakage at Class I cavities prepared by Er:YAG laser using three types of restorative materials *Journal of Clinic Laser Medicine and Surgery* **16(6)** 227-231.

35. Ceballos L, Osorio R, Toledano M & Marshall GW (2001) Microleakage of composite restorations after acid or Er:YAG laser cavity treatments *Dental Materials* **17(4)** 340-346.

36. Armengol V, Jean A, Enkel B, Assoumou M & Hamel H (2002) Microleakage of Class V composite restorations following Er:YAG and Nd:YAP laser irradiation compared to acid-etch: An *in vitro* study *Lasers in Medical Science* **17(2)** 93-100.

37. Gutknecht N, Apel C, Schäfer C & Lampert F (2001) Microleakage of composite fillings in Er,Cr:YSGG laser-prepared Class II cavities *Lasers in Surgery and Medicine* **28(4)** 371-374.

38. Hossain M, Kimura Y, Nakamura Y, Yamada Y, Kinoshita JI & Matsumoto K (2001) A study on acquired acid resistance of enamel and dentin irradiated by Er, Cr: YSGG laser *Journal of Clinic Laser Medicine and Surgery* **19(3)** 159-163.