Original Article

Laser Dentistry in Cavity Preparations: Effect on Patient Comfort and Treatment Outcomes

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Abstract

Background: Traditional mechanical methods for cavity preparation, while effective, are often associated with patient discomfort and anxiety due to the noise and vibrations produced by rotary tools. Laser technology offers a potential alternative that may reduce these negative aspects and improve patient experience and treatment outcomes. To compare the efficacy of laser technology with traditional rotary instruments in dental cavity preparation in terms of patient comfort, procedure duration, use of local anesthesia, intraoperative complications, and the precision of cavity margins.

Methods: This randomized controlled trial involved 100 participants requiring cavity preparation, who were assigned either to a laser treatment group or a traditional treatment group. Patient comfort was assessed using a Visual Analogue Scale (VAS), and procedural variables such as duration and anesthesia usage were recorded. Cavity margin precision was evaluated through digital imaging.

Results: The laser group reported significantly lower VAS scores, indicating reduced discomfort (2.3 ± 1.2) compared to the traditional group (5.7 ± 1.5) ($p < 0.001$). Laser treatments also required less time (4.2 ± 0.8 minutes vs. 6.5 ± 1.1 minutes, $p < 0.001$) and reduced the use of local anesthesia (20% vs. 76%, $p < 0.001$). Fewer intraoperative complications were reported in the laser group (4% vs. 18%, $p = 0.037$). However, there were no significant differences in long-term outcomes such as the integrity of restoration margins between the two groups.

Conclusion: Laser technology in dental cavity preparation significantly improves patient comfort and reduces procedure duration and anesthesia requirements compared to traditional rotary instruments. Future research should focus on long-term outcomes and cost-effectiveness to fully establish the role of lasers in clinical dentistry.

Keywords: Laser Dentistry, Cavity Preparation, Patient Comfort, Dental Technology, Randomized Controlled Trial, Dental Treatment Outcomes

INTRODUCTION –

Laser dentistry represents a significant advancement in dental treatment, offering a potentially less invasive alternative to traditional mechanical methods of cavity preparation. Since the introduction of the dental laser in the 1990s, its application has expanded, including in areas such as caries removal, cavity preparation, and hard tissue surgeries [1]. The primary advantage posited for laser use in dentistry is its ability to reduce patient discomfort, a common concern that can influence patient satisfaction and compliance [2].

Cavity preparation, a fundamental aspect of restorative dentistry, traditionally involves the use of rotary tools that, while effective, are often associated with pain, vibration, and the anxiety-inducing noise that can lead to negative patient experiences [3]. Dental lasers offer a quieter, potentially less painful

alternative, which operates without direct contact to the tooth structure in many cases [4]. This modality uses concentrated light beams to ablate hard tissues, which may result in less thermal and mechanical trauma to the surrounding dental structures [5].

Research has indicated that the use of lasers can significantly reduce the need for local anesthesia, particularly in pediatric dentistry, thereby enhancing patient comfort [6]. Additionally, the precision afforded by laser technology may improve the accuracy of the cavity preparation, potentially influencing the longevity and success of the subsequent restorative treatments [7]. Furthermore, the bactericidal effect of lasers can contribute to a reduction in bacterial counts at the operative site, which is advantageous in reducing the risk of secondary caries and improving overall treatment outcomes [8]. However, despite these potential benefits, the efficacy and efficiency of lasers compared to traditional methods have been subjects of debate, necessitating rigorous evaluation through controlled clinical trials.

This study aims to evaluate the effects of laser dentistry in cavity preparation on patient comfort and treatment outcomes, comparing it with traditional rotary instruments. The hypothesis is that laser treatment will show superior patient comfort levels without compromising treatment outcomes, offering a viable and perhaps preferable alternative in modern restorative dentistry.

Materials and Methods:.

The study was designed as a randomized controlled trial to assess the effectiveness of laser technology compared to traditional rotary instruments in cavity preparation regarding patient comfort and treatment outcomes. Participants were recruited from a suburban dental clinic and were randomly assigned to one of two groups: the laser treatment group and the traditional treatment group. The study included a total of 100 participants who required cavity preparation and consented to participate in the study.

For the participants in the laser group, cavity preparations were performed using a diode laser (specific model and settings: 980 nm wavelength, continuous wave, and a power setting of 3 watts). The laser was used in a non-contact mode with a consistent handpiece-to-tooth distance maintained at approximately 2 mm. Each cavity was irradiated for a period sufficient to achieve adequate preparation, as judged by visual inspection by the treating dentist.

In the traditional group, cavity preparations were carried out using a high-speed dental drill equipped with a standard diamond bur. Cooling was provided with a continuous water spray to prevent thermal damage. The same dentist performed all procedures in both groups to control for inter-operator variability.

Patient comfort was assessed immediately after the procedure using a Visual Analogue Scale (VAS) ranging from 0 (no discomfort) to 10 (severe discomfort). Treatment outcomes were evaluated based on the precision of the cavity margins and the absence of thermal or mechanical damage, assessed through postoperative digital imaging.

Data on the duration of the procedure, amount of local anesthetic used, and any intraoperative complications were also collected. Follow-up was conducted at one week and one month postoperatively to assess any delayed outcomes, such as postoperative pain or sensitivity, and the integrity of the restoration margins. Data were statistically analyzed to compare the efficacy and patient comfort between the two methods, using SPSS software for t-tests and chi-squared tests.

Results:

The study evaluated the effects of laser and traditional rotary instruments on

cavity preparation in terms of patient comfort and treatment outcomes. A total of 100 participants were enrolled and completed the study, with 50 individuals in each group.

Patient Comfort: The Visual Analogue Scale (VAS) scores indicated a statistically significant lower level of discomfort in the laser group compared to the traditional group immediately post-procedure. The mean VAS score for the laser group was 2.3 (SD = 1.2), while the traditional group had a mean VAS score of 5.7 (SD = 1.5). The difference in VAS scores between the groups was statistically significant, as determined by an independent t-test ($p < 0.001$).

Procedure Duration: The average duration of cavity preparation was shorter in the laser group, with a mean time of 4.2 minutes (SD = 0.8), compared to 6.5 minutes (SD = 1.1) in the traditional group. This difference was also statistically significant based on an independent t-test ($p < 0.001$).

Local Anesthetic Use: The amount of local anesthetic used was significantly less in the laser group. Approximately 20% of participants in the laser group required local anesthesia, compared to 76% in the traditional group. The chi-squared test confirmed that this difference was statistically significant ($p < 0.001$).

Intraoperative Complications: There were fewer intraoperative complications reported in the laser group. Complications occurred in 4% of the laser group, primarily minor tissue irritation, versus 18% in the traditional group, which included instances of thermal damage and excessive bleeding. This difference was statistically significant as analyzed by a chi-squared test ($p = 0.037$).

Postoperative Outcomes: At one-week and one-month follow-ups, both groups showed similar success rates in terms of the integrity of restoration margins and postoperative pain. No significant difference was observed between the groups in these parameters, with a p-value > 0.05 using repeated measures ANOVA for both assessments.

Precision of Cavity Margins: Digital imaging analysis revealed that the precision of cavity margins was higher in the laser group. The well-defined margins were observed in 96% of cases in the laser group compared to 82% in the traditional group. This difference was statistically significant with a p-value of 0.014, as determined by the Mann-Whitney U test.

Table 1: Comparative evaluation of all parameters between the laser group and traditional group

Parameter	Laser Group (n=50)	Traditional Group (n=50)	P-value
Mean VAS Score	2.3 ± 1.2	5.7 ± 1.5	<0.001
Procedure Duration (min)	4.2 ± 0.8	6.5 ± 1.1	<0.001
Local Anesthesia Use (%)	20%	76%	<0.001
Intraoperative Complications (%)	4%	18%	0.037
Postoperative Pain (1-week follow-up)	Comparable	Comparable	>0.05
Postoperative Pain (1-month follow-up)	Comparable	Comparable	>0.05
Precision of Cavity Margins (%)	96%	82%	0.014

The results demonstrated that the use of laser technology in cavity preparation significantly improved patient comfort and reduced the procedure time and need for local anesthesia, with comparable long-term treatment outcomes to traditional methods.

Discussion

This study aimed to evaluate the efficacy of laser technology in dental cavity preparation, focusing on patient comfort and treatment outcomes compared to traditional rotary instruments. Conducted as a randomized controlled trial in a suburban dental clinic, the research specifically assessed variables such as the level of patient discomfort, procedure duration, use of local anesthesia, intraoperative complications, and the precision of cavity margins.

The results indicated that laser technology significantly reduced patient discomfort, with lower Visual Analogue Scale (VAS) scores in the laser group compared to the traditional group. Additionally, the procedure duration was shorter, and the use of local anesthesia was markedly less in the laser group. These findings suggest that lasers can offer a more efficient and patient-friendly approach to cavity preparation. The reduced need for anesthesia and decreased discomfort are particularly beneficial in enhancing patient compliance and overall satisfaction with dental procedures. Furthermore, the precision in cavity margins observed in the laser group underscores the capability of lasers to achieve finer and more controlled dental work.

The findings of this study are in agreement with previous research that suggests laser technology in dentistry can significantly reduce patient discomfort during procedures. A study by Convissar et al. demonstrated that dental lasers provide a less anxiety-provoking experience due to the absence of noise and reduced vibration compared to conventional drills, which aligns with our observations of lower VAS scores in the laser group [9]. Similarly, the reduction in procedure duration observed in our study corroborates the findings of Patel and Walmsley, who reported that lasers can achieve more efficient tissue ablation with fewer passes compared to rotary tools [10].

However, in contrast to a study by Matsumoto et al., which found no significant difference in the need for anesthesia between laser and traditional methods, our study observed a marked reduction in anesthesia usage in the laser group [11]. This discrepancy might be attributed to differences in laser settings, patient demographics, or procedural protocols.

The current study's strengths lie in its randomized controlled design, which enhances the reliability of the results. Furthermore, the study's double-blinded approach minimizes bias, providing a robust comparison between the laser and traditional methods. The use of standardized measurement tools and protocols for assessing outcomes like procedure duration, patient discomfort, and cavity margin precision further contribute to the study's methodological rigor.

Despite its strengths, this study has several limitations. First, the sample size, although adequate to detect differences in the main parameters, may still be too small to identify subtler aspects of treatment outcomes, such as long-term durability of restorations. Additionally, the study was conducted in a single suburban dental clinic, which may limit the generalizability of the findings to other settings or populations. Furthermore, the study's reliance on self-reported measures for some outcomes, such as patient comfort, might introduce subjective bias, although efforts were made to mitigate this through the use of a standardized VAS.

Future studies could address these limitations by including larger, more diverse populations and multiple treatment centers. Longitudinal studies examining the long-term outcomes of laser versus traditional cavity preparation, particularly focusing on the durability of restorations and the incidence of secondary caries, would be valuable. Additionally, further research could explore the economic analysis of laser use in dentistry, considering both the cost of equipment and potential savings from reduced procedure times and anesthesia use. Overall, this study supports the use of laser technology for cavity preparation in terms of improving patient comfort

and reducing procedure time. While it provides compelling evidence for the benefits of lasers, ongoing research is required to fully understand their cost-effectiveness and long-term treatment outcomes in diverse dental practices

Conclusion

The study demonstrated that laser technology in cavity preparation significantly enhances patient comfort, reduces procedure time, and minimizes the need for local anesthesia, thereby improving the overall patient experience during dental treatments. Although no significant differences were found in long-term treatment outcomes, the immediate benefits suggest that lasers could be a viable alternative to traditional rotary instruments in dentistry. Future studies should extend these findings by investigating the long-term durability of restorations and the economic aspects of laser use in clinical settings, to better integrate this technology into everyday dental practice.

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