Submitted: 17 June, 2024 Accepted: 05 August, 2024 Published: 03 September, 2024 DOI:10.22514/jocpd.2024.118

ORIGINAL RESEARCH

Journal of Clinical Pediatric Dentistry

Clinical application of Er:YAG laser and traditional dental turbine in caries removal in children

Pinpin Xu[1], Cong Ren[1], Yinhua Jiang[1], Junjie Yan[1], Mengting Wu[1,2,*]

[1]Department of Stomatology, Lishui People's Hospital, 323000 Lishui, Zhejiang, China
[2]Department of Pediatric Stomatology, Stomatology Hospital Affiliated to Lishui University Medical College, 323000 Lishui, Zhejiang, China

***Correspondence**
wumengting40410@163.com
(Mengting Wu)

Abstract

This study compares the clinical efficacy of erbium-doped:yttrium-aluminium-garnet (Er:YAG) laser and traditional dental turbine in caries removal in children. The study cohort comprised 78 children aged 5 to 10 years with caries in two symmetrical maxillary molars. Different carious sides of the same child were randomly divided into control and observed sides. For each child, the caries on the control side were treated with a traditional dental turbine, while the observed side was treated with an Er:YAG laser. The study evaluated the use of anesthetics, pain levels, tooth hypersensitivity and the occurrence and severity of tooth fractures during caries removal with different methods. Additionally, the clinical anxiety and cooperative behavior of the children were observed. The time required for caries removal and cavity preparation by both methods was recorded, and the success rate of treatment was assessed after one year of follow-up. The results indicated a significant reduction in the use of anesthetics, pain and the incidence and severity of tooth hypersensitivity with the use of Er:YAG laser ($p < 0.05$). No significant difference was found in the occurrence of tooth fractures between the two groups ($p > 0.05$). The children treated with Er:YAG laser demonstrated better clinical anxiety levels and cooperative behavior. However, the time required for cavity preparation was longer with the use of Er:YAG laser ($p < 0.05$). After a 12-month follow-up, there was no significant difference in the success rate of treatment between the two groups ($p > 0.05$). In conclusion, compared to the traditional dental turbine, the use of Er:YAG laser improves treatment comfort and cooperation in children with caries and reduces the need for intraoperative anesthetics.

Keywords

Dental caries; Er:YAG laser; Dental turbine

1. Introduction

Dental caries is the most common oral disease in clinical practice. It will reduce the masticatory function of children and lead to food debris stagnating in the oral cavity. If deciduous dental caries develops into apical periodontitis, it will affect the tooth-germ of succedaneous teeth, resulting in caries in newly erupted permanent teeth. Because the decreased masticatory function will also affect the nutritional intake of children, dental caries will also reduce the body immunity and affect their growth and development of children [1–3]. The standard procedures for treating caries involve caries removal, cavity preparation and filling. Caries removal is the initial and most daunting step, often resulting in low cooperation from children [4–6]. The dental turbine, commonly used in clinical practice, facilitates swift and labor-saving caries removal. However, the noise and significant vibration associated with turbine use reduce children's intraoperative cooperation, complicating the treatment process [7–10]. Additionally, the cooling water system used during caries removal increases discomfort, particularly for children, necessitating local anesthesia and thereby increasing treatment difficulty and surgical risk. The Er laser is a mid-infrared laser maximally absorbed by water and hydroxyapatite in dental tissue, producing a "microburst" effect that effectively removes carious tissue from enamel and dentin [11, 12]. Compared with traditional turbines, Er:YAG laser treatment is more comfortable. However, due to the individual differences in biological tissues, there is no uniform standard for Er:YAG laser parameter selection, irradiation angle, distance and other operating procedures. It has been reported that Er:YAG laser will reduce the bond strength, denature the dentin surface layer, destroy the wet bonding, and is not conducive to the formation of mixed layer and resin tag. Hence, the practical application value is still in the research stage [13]. In this study, we compared the clinical application value of the traditional dental turbine and the Er laser in children with dental caries to determine a more suitable method for caries removal in this population.

2. Materials and methods

2.1 General data

Seventy-eight children with dental caries admitted to the hospital from January 2021 to January 2022 were enrolled in the study. All procedures performed in studies involving human participants were in accordance with the standards upheld by the Ethics Committee of Lishui People's Hospital. The study inclusion criteria were children aged 5 to 10 years with caries in two symmetrical maxillary molars, specifically classified as shallow dentin caries (degree II), where the cavity floor is in superficial dentin with normal dentin separating the caries from the pulp cavity, and no history of prior oral treatment. All treatment procedures were performed by the same dentist who had worked clinically for ≥5 years, and parental consent was obtained for participation. Comparatively, those unable to cooperate during treatment sessions, showing radiographic evidence of caries extending into the dental pulp, and those with dental dysplasia or malformed teeth unsuitable for conventional cavity preparation were excluded from the study. Sample size calculation basis: The main outcome measure of this clinical experimental study is the success rate of caries removal. The sample size is calculated by using the above indicators, respectively. The calculation formula of paired *t*-test was utilized: $N = [\frac{(Z_{\alpha/2} + Z_{\beta})\delta}{\partial}]^2$, $\alpha = 0.05$, $\beta = 0.10$. The calculation outcome of the maximum sample size calculated by each indicator is 68. The sample size is expanded to 78 considering the loss to follow-up and the actual situation.

2.2 Treatments

2.2.1 Therapeutic instruments and reagents

The instruments and reagents utilized in the study included the HANS-MDWL6 erbium laser dental therapeutic instrument (Shenzhen, China, Han's Laser Technology Industry Group Co., Ltd.), the PANA-MAX handpiece and NSK bur (Japan, NSK Group), a light curing machine (France, MINI LED), and Spectrum composite resin and Prime & Bond adhesive (Germany, Dentsply).

2.2.2 Treatment methods

Different carious sides of the same child were randomly divided into control and observed sides. The control side was decontaminated with a traditional dental turbine, while the observed side was decontaminated with an Er:YAG laser. According to the random number table, the solutions and the order of treating two carious teeth were determined. The children completed the treatment of two carious teeth in the same diagnosis and treatment.

(1) For each child in the study, decayed teeth on one side were treated using a traditional dental turbine (control side, n = 78), while the opposite side received treatment with an Er laser for caries removal (observed side, n = 78). Treatment allocation was determined using a random number table to ensure a balanced assignment. The procedure for caries removal with the traditional dental turbine followed established principles: removal of carious and softened tooth tissues to reduce pulp irritation, protect the pulp, and preserve healthy tooth structure. Initially, softened superficial carious tissue was excavated using a dental excavator. Subsequently, a high-speed dental turbine handpiece (Dental Diamond Burs, 300,000 rpm/min) was used for the efficient removal of carious tissue, followed by a low-speed handpiece (Carbide Dental Burs, 15,000 rpm/min) for deeper caries. NO. 2 round bur was utilized. Probe checks the efficacy of caries removal. Proper technique with the high and low-speed handpieces was strictly adhered to, with attention to intraoperative heating and cooling management.

(2) Caries removal using the Er:YAG laser (HANS-MDWL6 erbium laser dental therapeutic instrument) followed specific protocols for caries removal and cavity preparation. The laser parameters were set at 300 mJ and 8 Hz frequency. The laser probe was positioned within 1 mm of the caries lesion and aligned accordingly. A non-contact scanner was utilized to sculpt the cavity shape by removing carious tissue. Different treatment parameters were applied depending on whether enamel or dentin was targeted. The procedure involved iterative passes until all caries tissue was completely eliminated.

(3) During treatment, if a child experienced unbearable pain, local anesthesia using 2% lidocaine hydrochloride was administered with parental consent before proceeding. Following complete caries removal and cavity preparation, restoration and filling procedures were conducted, which involved applying 35% phosphoric acid etching for 15 seconds, followed by a 20-second rinse and gentle drying. Subsequently, light-cured adhesive (B-7202P, 6 mL per bottle, CFDA (I) 20163630686) was applied according to manufacturer instructions and cured for 10 seconds with light activation. Resin (Bullet pack: 20 × 0.25 g/box, SFDA (I) 20133630133) was then applied and cured for 20 seconds to facilitate occlusal adjustment and polishing.

2.2.3 Outcome measures

(1) The assessment during treatment of two caries removal methods included scoring based on the following criteria: the use of anesthetics (not used: 0 points, used once: 1 point, used twice: 2 points), presence of pain (none: 0 points, mild pain: 2 points, moderate pain tolerated: 4 points, severe pain requiring medication: 6 points), tooth hypersensitivity (none: 0 points, mild: 2 points, moderate: 4 points, severe: 6 points) and tooth fracture (none: 0 points, mild: ≤2 mm: 2 points, moderate: 3–5 mm: 4 points, severe: ≥6 mm: 6 points).

(2) To compare anxiety and cooperative behavior in children undergoing treatment with two caries removal methods [14], the Venham Clinical Anxiety and Cooperative Behavior Rating Scale was used. This scale ranges from 0 to 5 points, where scores represent the following states: 0 for free, 1 for uncomfortable, 2 for nervous, 3 for reluctant, 4 for fearful and 5 for out of control. Doctors assign scores based on the child's expression, interaction, body language, and speech intonation during the procedure. Higher scores indicate greater anxiety and poorer cooperative behavior.

(3) The time for caries removal and cavity preparation was compared between the two groups.

(4) The success rate of caries removal in both groups was evaluated by having children return to the hospital 12 months post-surgery. Treatment success was determined based on well-established criteria [15], including asymptomatic teeth,

intact fillings, smooth surface, absence of loosening or shedding, good marginal adaptation and no secondary caries in the treated area. Treatment was considered unsuccessful if pulpitis symptoms were present, significant marginal staining of filling material occurred, gaps or loosening occurred, or secondary dental caries developed in the treated area.

Note: All indicators were measured, evaluated, and collected by the same dentist who had received systematic training to ensure accuracy and consistency of the outcomes.

2.2.4 Data collection

Data collection and entry were performed using a two-person data entry method to ensure accuracy.

Two-person data entry refers to that two entry personnel use the same data structure to independently enter data information, and this method can further check the accuracy of data by comparing the entry results of two entry personnel.

2.2.5 Statistical methods

Data were processed using SPSS 27.0 statistical software (IBM, Chicago, IL, USA). Measurement data were presented as mean ± standard deviation (±s). Independent sample *t*-tests were applied to compare means between groups. Enumeration data were presented as percentages (n (%)), and χ^2 tests were used for comparisons. Rank sum tests were utilized for ordinal data, with $p < 0.05$ considered statistically significant.

3. Results

3.1 Comparison of narcotic use, pain, tooth hypersensitivity and tooth fracture during treatment between both groups

The use of anesthetics, pain and tooth hypersensitivity were lower on the observed side compared to the control side during treatment, with statistically significant differences ($p < 0.05$). There was no statistically significant difference in tooth fracture between the groups ($p > 0.05$, Table 1).

3.2 Comparison of clinical anxiety and cooperative behavior between the two methods for caries removal

The clinical anxiety and cooperative behavior of the children were better on the observed side compared to the control side during caries removal, with statistically significant differences ($p < 0.05$, Table 2).

TABLE 1. Comparison of narcotic use, pain, tooth hypersensitivity and tooth fracture during treatment between both groups (n (%)).

Variables	Grading (Point)	Observed side (n = 78)	Control side (n = 78)	*Uc* value	*p* value
Narcotic use					
	No	76 (97.44)	68 (87.18)		
	Used once	2 (2.56)	10 (12.82)	5.740	0.017
	Used twice	0 (0.00)	0 (0.00)		
Pain					
	No	62 (79.49)	40 (51.28)		
	Mild	16 (20.51)	22 (28.21)	17.330	<0.001
	Moderate	0 (0.00)	16 (20.51)		
	Severe	0 (0.00)	0 (0.00)		
Tooth hypersensitivity					
	No	74 (94.87)	50 (64.10)		
	Mild	4 (5.13)	20 (25.64)	23.050	<0.001
	Moderate	0 (0.00)	8 (10.26)		
	Severe	0 (0.00)	0 (0.00)		
Tooth fracture					
	No	78 (100.00)	75 (96.15)		
	Mild	0 (0.00)	3 (3.85)	3.040	0.081
	Moderate	0 (0.00)	0 (0.00)		
	Severe	0 (0.00)	0 (0.00)		

TABLE 2. Comparison of clinical anxiety and cooperative behavior between two methods for caries removal (n (%)).

Group	n	Grade 0	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Observed side	78	20 (25.64)	26 (33.33)	11 (14.10)	15 (19.23)	6 (7.696)	0 (0.00)
Control side	78	9 (11.54)	11 (14.10)	18 (23.08)	13 (16.67)	20 (25.640)	7 (8.97)
Hc value				19.490			
p value				<0.001			

3.3 Comparison of time for caries removal and cavity preparation between both groups

All treatment procedures were performed by the same dentist, who had at least 5 years of clinical experience. The time for caries removal and cavity preparation was longer on the observed side compared to the control side, with a statistically significant difference ($p < 0.05$, Table 3).

TABLE 3. Comparison of time for caries removal and cavity preparation between both groups ($\bar{x} \pm s$, min).

Group	n	Cavity preparation time
Observed side	78	14.33 ± 2.15
Control side	78	6.45 ± 1.78
t value		24.933
p value		<0.001

3.4 Comparison of follow-up results

After 12 months of follow-up, the treatment success rate was assessed, and the results showed no statistically significant difference in the treatment success rate between the two groups ($p > 0.05$, Table 4).

TABLE 4. Comparison of follow-up results (n (%)).

Group	n	Treatment success	Treatment failure
Observed side	78	77 (98.72)	1 (1.28)
Control side	78	75 (96.15)	3 (3.85)
χ^2 value		1.026	
p value		0.311	

4. Discussion

Turbine caries removal makes children feel nervous and fearful. Current research has mainly focused on finding safer and more efficient methods to remove caries, prepare cavities, and improve treatment cooperation among children with caries [16–20]. The Er:YAG laser is a mid-infrared laser with a wavelength of 2.94 μm and an absorption coefficient close to the absorption peak of water, making it easily absorbed by water. Hydroxyapatite, the main component of dental hard tissues, also has a strong absorption of Er:YAG laser [21–23]. Therefore, after the Er laser is absorbed by water and hydroxyapatite in the tooth, the local temperature increases, and the volume expands, creating a "microburst" effect that cuts the tooth [24, 25]. This mechanism has led to the gradual application of the Er laser in caries removal and cavity preparation. Er:YAG laser cavity removal is a non-contact punctate removal method. The head of laser optical fiber drill directly contacts the dental tissue, which can effectively reduce the pain during the treatment of children and avoid the discomfort caused by jaw vibration [26]. Clinical studies have found that the Er laser for cavity preparation has the advantages of less noise, less vibration, and higher comfort, making it more easily accepted by patients [27]. In this present study, it was found that 12.82% of children required anesthesia when using the traditional turbine for cavity preparation, while only 2.56% required anesthesia when using the Er laser. This indicates that the Er laser can reduce the use of anesthetics during surgery in children with caries. Moreover, the degree of perceived pain and the incidence of dental hypersensitivity symptoms were significantly lower on the observed side compared to the control side. Clinical anxiety and behavior grades were also lower on the observed side. These findings suggest that the use of the Er laser for cavity preparation is more comfortable, reduces intraoperative anxiety and tension, and improves surgical cooperation in children with caries, which is consistent with previous studies [28]. However, the treatment duration for caries removal using Er laser is significantly longer compared to dental turbines, primarily due to the laser's slower cutting speed and lower treatment efficiency. This limitation represents a significant barrier to the widespread clinical adoption of Er lasers.

Er laser treatment has been demonstrated to result in a regularly shaped tooth surface resembling fish scales, with elimination of the smear layer and open dentinal tubules. This surface modification increases surface area and free energy, potentially enhancing resin bonding strength and improving the success rate of resin fillings [29]. Conversely, opposing viewpoints suggest that cracks may develop on enamel and dentin surfaces post-Er laser treatment, potentially compromising resin bonding strength [30]. A 12-month follow-up study indicated comparable short-term efficacy between the two methods for caries removal and cavity preparation. However, due to study constraints, long-term therapeutic effects were not statistically analyzed, limiting full understanding of their comparative long-term efficacy. In addition, the sample size of this study is not large, and it is a single-center study, with limited sample representativeness. Subsequently, the experimental protocol can be improved for the above shortcomings to further confirm the reliability of the conclusion. Furthermore, this study was done by the same dentist, and their treatment outcomes may be influenced by the experience of

this physician, which may also bias the experimental results.

5. Conclusions

In conclusion, compared to traditional dental turbines for caries removal and cavity preparation, Er laser application enhances treatment comfort and cooperation among pediatric patients with caries and reduces the need for intraoperative anesthesia. However, the low cutting efficiency of Er lasers on dental hard tissues remains a significant area for improvement.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

PPX and CR—designed the study, completed the experiment and supervised the data collection. YHJ—analyzed the data, interpreted the data. JJY and MTW—prepare the manuscript for publication and reviewed the draft of the manuscript. All authors have read and approved the manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical approval was obtained from the Ethics Committee of Lishui People's Hospital (ethical approval number: 2023-003). Parental consent was obtained for participation.

ACKNOWLEDGMENT

Not applicable.

FUNDING

This research received no external funding.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

[1] Kazeminia M, Abdi A, Shohaimi S, Jalali R, Vaisi-Raygani A, Salari N, *et al*. Dental caries in primary and permanent teeth in children's worldwide, 1995 to 2019: a systematic review and meta-analysis. Head & Face Medicine. 2020; 16: 22.

[2] Corrêa-Faria P, Viana KA, Raggio DP, Hosey MT, Costa LR. Recommended procedures for the management of early childhood caries lesions—a scoping review by the Children Experiencing Dental Anxiety: Collaboration on Research and Education (CEDACORE). BMC Oral Health. 2020; 20: 75.

[3] Turton B, Sullivan S, Chher T, Hak S, Sokal-Gutierrez K, Wieringa F, *et al*. Caries incidence is associated with wasting among cambodian children. Journal of Dental Research. 2023; 102: 157–163.

[4] Jardim JJ, Mestrinho HD, Koppe B, de Paula LM, Alves LS, Yamaguti PM, *et al*. Restorations after selective caries removal: 5-year randomized trial. Journal of Dentistry. 2020; 99: 103416.

[5] Cardoso M, Coelho A, Lima R, Amaro I, Paula A, Marto CM, et al. Efficacy and patient's acceptance of alternative methods for caries removal—a systematic review. Journal of Clinical Medicine. 2020; 9: 3407.

[6] Abed R, Bernabe E, Sabbah W. Family impacts of severe dental caries among children in the United Kingdom. International Journal of Environmental Research and Public Health. 2019; 17: 109–118.

[7] Zambrano-Achig P, Viteri-García A, Verdugo-Paiva F. Chemo-mechanical removal versus conventional removal for deep caries lesion. Medwave. 2022; 22: e8320.

[8] Chevalier V, Le Fur Bonnabesse A, Duncan HF. Frightened of the pulp? A qualitative analysis of undergraduate student confidence and stress during the management of deep caries and the exposed pulp. International Endodontic Journal. 2021; 54: 130–146.

[9] Urs P, Smitha S, Abinaya R, Janani J. Comparing the efficacy of three minimally invasive techniques on demineralized dentin in primary teeth and evaluating its residual dentin and microhardness levels: an *in vitro* study. International Journal of Clinical Pediatric Dentistry. 2021; 13: 585–589.

[10] Sinha A, Osnes C, Keeling AJ. Pilot study assessing 3D-printed teeth as a caries removal teaching tool. European Journal of Dental Education. 2022; 26: 329–336.

[11] Curylofo-Zotti FA, Fernandes MP, Martins AA, Macedo AP, Nogueira LFB, Ramos AP, *et al*. Caries removal with Er:YAG laser followed by dentin biomodification with carbodiimide and chitosan: Wettability and surface morphology analysis. Microscopy Research and Technique. 2020; 83: 133–139.

[12] Valério RA, Galo R, Galafassi D, Corona SAM, Borsatto MC. Four-year clinical prospective follow-up of resin composite restoration after selective caries removal using Er:YAG laser. Clinical Oral Investigations. 2020; 24: 2271–2283.

[13] Belcheva A, Shindova M. Efficiency of ER:YAG laser therapy in combination with behaviour management technique in reducing anxiety among paediatric dental patients—a study protocol for a randomised clinical trial. BMJ Open. 2022; 12: e054523.

[14] Zhou F, Zhang S, Ma W, Xiao Y, Wang D, Zeng S, *et al*. The long-term effect of dental treatment under general anaesthesia or physical restraints on children's dental anxiety and behaviour. European Journal of Paediatric Dentistry. 2022; 23: 27–32.

[15] Clarkson JE, Ramsay CR, Ricketts D, Banerjee A, Deery C, Lamont T, *et al*. Selective Caries Removal in Permanent Teeth (SCRiPT) for the treatment of deep carious lesions: a randomised controlled clinical trial in primary care. BMC Oral Health. 2021; 21: 336.

[16] Melo L, Blum IR, Foxton RM. Should new operating procedures arising from COVID-19 make us re-think our management of deep caries? Primary Dental Journal. 2022; 11: 72–74.

[17] Lee W, Kwon HB. Vibroacoustic analysis of dental air turbine noise. BDJ Open. 2022; 8: 27.

[18] Liebich T, Lack L, Hansen K, Zajamšek B, Lovato N, Catcheside P, *et al*. A systematic review and meta-analysis of wind turbine noise effects on sleep using validated objective and subjective sleep assessments. Journal of Sleep Research. 2021; 30: e13228.

[19] Gibbison R, Crozier R. Are RMGIC restorations as effective with or without selective caries removal in primary molars? Evidence-Based Dentistry. 2021; 22: 132–133.

[20] Alkhouli MM, Al Nesser SF, Bshara NG, AlMidani AN, Comisi JC. Comparing the efficacies of two chemo-mechanical caries removal agents (2.25% sodium hypochlorite gel and brix 3000), in caries removal and patient cooperation: a randomized controlled clinical trial. Journal of Dentistry. 2020; 93: 103280.

[21] Fried WA, Chan KH, Darling CL, Curtis DA, Fried D. Image-guided ablation of dental calculus from root surfaces using a DPSS Er:YAG laser. Lasers in Surgery and Medicine. 2020; 52: 247–258.

[22] Lopes MS, Pereira DL, de Oliveira Mota CCB, Amaral MM, Zezell DM, Gomes ASL. The lingual enamel morphology and bracket shear bond strength influenced by Nd:YAG laser and aluminum oxide sandblasting preconditioning. Clinical Oral Investigations. 2021; 25: 1151–1158.

[23] Grzech-Leśniak K, Matys J. The effect of Er:YAG lasers on the reduction of aerosol formation for dental workers. Materials. 2021; 14: 2857.

[24] Li T, Zhang X, Shi H, Ma Z, Lv B, Xie M. Er:YAG laser application in caries removal and cavity preparation in children: a meta-analysis. Lasers in Medical Science. 2019; 34: 273–280.
[25] Xiong Z, Tu S, Jiang L, Cheng T, Jiang H. Effect of nanosecond- and microsecond-pulse Er,Cr:YSGG laser ablation on dentin shear bond strength of universal adhesives. Lasers in Medical Science. 2022; 37: 3285–3290.
[26] Kermanshah H, Ranjbar Omrani L, Ghabraei S, Fekrazad R, Daneshparvar N, Bagheri P. Direct pulp capping with ProRoot MTA alone and in combination with Er:YAG laser irradiation: a clinical trial. Journal of Lasers in Medical Sciences. 2020; 11: S60–S66.
[27] Curylofo-Zotti FA, Oliveira VC, Marchesin AR, Borges HS, Tedesco AC, Corona SAM. *In vitro* antibacterial activity of green tea-loaded chitosan nanoparticles on caries-related microorganisms and dentin after Er:YAG laser caries removal. Lasers in Medical Science. 2023; 38: 50.
[28] Li T, Zhang X, Shi H, Ma Z, Lv B, Xie M. Er:YAG laser application in caries removal and cavity preparation in children: a meta-analysis. Lasers in Medical Science. 2019; 34: 273–280.
[29] Petričević GK, Katić M, Anić I, Salarić I, Vražić D, Bago I. Efficacy of different Er:YAG laser-activated photoacoustic streaming modes compared to passive ultrasonic irrigation in the retreatment of curved root canals. Clinical Oral Investigations. 2022; 26: 6773–6781.
[30] Souza-Filho CB, Moris ICM, Colucci V, Faria ACL, Gomes ÉA. Is the Er:YAG laser affect the surface characteristics and bond strength of Y-TZP? Brazilian Dental Journal. 2021; 32: 83–92.

How to cite this article: Pinpin Xu, Cong Ren, Yinhua Jiang, Junjie Yan, Mengting Wu. Clinical application of Er:YAG laser and traditional dental turbine in caries removal in children. Journal of Clinical Pediatric Dentistry. 2024; 48(5): 183-188. doi: 10.22514/jocpd.2024.118.