

THE EFFECT OF ER:YAG LASER THERAPY IN COMBINATION WITH BEHAVIOUR MANAGEMENT TECHNIQUE ON THE REDUCTION OF ANXIETY IN PAEDIATRIC DENTAL PATIENTS

Maria Shindova[✉], Ani Belcheva

Received on June 28, 2021

Presented by P. Vassileva, Member of BAS, on July 30, 2021

Abstract

This study aimed to evaluate the anxiety in paediatric patients during caries treatment, with Er:YAG laser and conventional rotary instruments, in combination with child-management technique Latent inhibition. A group of 126 6–12-year-old children with one or more untreated dentine carious lesions (ICDAS code 05) on the occlusal surface of a primary molar was divided into four equal treatment subgroups. A standardized caries treatment was performed with Erbium:YAG laser or conventional rotary instruments. In the intervention groups, Latent inhibition was used as an anxiety-management technique. During the procedure, objective and subjective stress parameters were recorded. Statistically significant reduction in mean heart rate and self-anxiety scores was seen in the combination of Er:YAG laser caries removal and child-management technique ($p < 0.05$). The use of laser cavity preparation in combination with the child-management technique Latent inhibition is the most effective method during the dental treatment of children. Er:YAG laser alone showed an advantage over the conventional method and equivalent effect to the combined use of conventional rotary instruments and behaviour management technique.

Key words: lasers, anxiety, management technique, paediatric dentistry

Introduction. In recent years, the treatment of caries lesions follows a completely new approach for minimal intervention called Minimal Invasive Dentistry

<https://doi.org/10.7546/CRABS.2024.07.15>

(MID) [1]. MID may involve the use of the conventional rotary instruments (CRI) – high-speed handpiece, only to get access to the carious tissues [1]. When providing dental care to child patients with a high level of dental anxiety, most paediatric dentists find the conventional method inefficient and uncomfortable. According to the principles of behavioural dentistry, as part of the paediatric postgraduate education, the so-called ‘4S’ principle must be adapted and modified to the individual clinical situation to provide adequate dental care to anxious paediatric patients [2]. The range of approaches can be divided into two sections – behaviour management techniques (BMTs), on the one hand, and alternative methods for caries removal, on the other. In an attempt to reduce dental anxiety, they can be mixed and matched in accordance with dentists’ choice.

As it has been known for more than 20 years that lasers are effective for caries excavation, laser paediatric dentistry has been rapidly developed. It offers total innovation and changes the conventional restorative treatment in pedodontics [3]. The high-power Er:YAG lasers and Er,Cr:YSGG lasers, part of the Erbium Laser Family, introduce to the paediatric dentists a safe ablation of hard dental tissues [4]. Owing to the promoted advantages such as minimal intervention and prevention, safety due to the low penetration depth of the laser beam, selective removal of caries lesion, lack of thermal damage, no pain perception and use of local anesthesia, a significant decrease of patient discomfort and dental anxiety and increase of subjective acceptance and tolerance of laser therapy in children, Er:YAG laser turns into an ideal laser for hard dental tissue therapy in anxious paediatric patients [3, 5].

Based on the concepts of MID, the use of BMTs during the treatment of anxious children to reduce their anxiety is required [1]. Several specific BMTs are not part of the regular curricula of dental students [5–7]. They have been used by paediatric dentists only. Such a psychological technique is Latent inhibition also known as Gradual exposure [8, 9]. It involves a series of several positive non-painful – check-ups and preventive procedures, before any invasive or painful dental manipulations. Step by step the child is exposed to potential anxiety-provoking procedures or instruments, resulting in an acquaintance with the dental setting and personnel, as well as being accustomed to dental treatment. Despite the specific indications, requiring preparation and higher time consumption, the use of this technique is very rewarding as the paediatric patient eventually becomes comfortable with the dental procedure and creates a feeling of ability to cope within the child [6, 7].

Over the recent years, dentists advance in using alternative methods for caries removal as part of their everyday practice. Therefore, the investigation of the combined use of the alternative strategies for caries treatment and the different BMTs is crucial for the present and future development of paediatric dentistry.

No publications reporting the efficacy and viability of the implementation of the known BMTs in the alternative caries treatment methods were retrieved.

Therefore, the study aimed to evaluate and compare the objective and subjective stress parameters in children during caries treatment using Er:YAG laser and CRI in combination with the child-management technique Latent inhibition. Additionally, a simple and easily implemented protocol for the prevention of dental anxiety and phobias is presented.

Material and methods. Selection of patients. The trial conducted is a randomized controlled clinical study. The study included 126 6–12-year-old children (mean age = 7.89 ± 1.73 years). A convenience sample of children was randomly selected from patients at the Department of Paediatric Dentistry who met the study's inclusion criteria as follows:

- children aged 6–12 years, in good general health;
- presence of ≥ 1 untreated dentine carious lesions (ICDAS code 05), without pulp involvement or pain, located on the occlusal surface of a second primary molar [10];
- presence of ≥ 1 permanent molar giving indications for pit and fissure sealing;
- patients with no previous laser treatment of carious lesions before the present study;
- verbal assent from the child willing to comply with all study procedures;
- obtained written informed consent by the patient's parent/guardian for participation in the study.

The exclusion criteria were:

- children with systemic diseases or physiological development delays;
- children with mental or cognitive problems;
- children undergoing medical treatment that might affect heart rate;
- children treated under general anesthesia;
- present infectious diseases.

The selected children were divided into four equal treatment subgroups (Table 1).

Clinical procedures. All treatments were carried out by the same operator, a specialist in pedodontics. In all subgroups, the procedures were performed without anesthesia.

In the experimental subgroups (III and IV), Latent inhibition was used as a BMT including several positive manipulations before any invasive or painful dental intervention. Thus, each child from the experimental subgroups had two visits to the dental office, whereas in the control subgroups each child had one visit – treatment of dental caries (Table 1).

In the laser subgroups (I and III) the enamel conditioning of the occlusal surfaces of the permanent molars before sealant application as well as the standardized caries treatment were performed with Er:YAG laser (LiteTouch, Syneron), emission wavelength 2940 nm. The parameter settings used were as follows:

T a b l e 1

Treatment subgroups in the study

VISIT	SUBGROUPS			
	subgroup I	subgroup II	subgroup III	subgroup IV
	Laser control subgroup	Rotary control subgroup	Laser experimental subgroup	Rotary experimental subgroup
First dental visit	1. Oral examination 2. Laser treatment of dental caries (without BMT)	1. Oral examination 2. Caries treatment with CRI (without BMT)	Latent inhibition + Interventions: 1. Oral examination 2. Professional oral hygiene 3. Sealant application after laser conditioning of the enamel	Latent inhibition + Interventions: 1. Oral examination 2. Professional oral hygiene 3. Sealant application
Second dental visit	–	–	Latent inhibition + Laser treatment of dental caries	Latent inhibition + Caries treatment with CRI

(control groups – without the use of BMT, experimental groups – using BMT, laser groups – using Er:YAG laser for treatment of hard dental tissues, rotary groups – using conventional rotary instruments for caries removal)

- laser conditioning of the occlusal enamel surface – tip-to-tissue distance 1.5 mm from the tooth surface; tip diameter 600 μm ; laser energy 70 mJ; pulse frequency 10 Hz; water spray level 8; average power 0.7 W; energy density 67 J/cm²;
- caries removal – enamel removal – energy 100–200 mJ; density 9.84–13.03 J/cm², pulse frequency 20 Hz; tip diameter 800 μm ; water spray level 8; tip-to-tissue distance 0.5÷1 mm from the surface; dentin removal – energy 100 mJ; density 9.84 J/cm², pulse frequency 20 Hz; tip diameter 800 μm ; water spray level 8; tip-to-tissue distance 0.5÷1 mm from the surface. The measured values were confirmed using a power meter.

In the conventional groups, the CRI (II and IV) – high-speed and low-speed dental handpieces, were used for the caries treatment.

Evaluation of dental anxiety. During the procedure, objective and subjective stress parameters were recorded. The patient's subjective anxiety was recorded two times: at the beginning and the end of each dental visit, using a modified version of the self-report Faces Scale by LEBARON and ZELTZER (Fig. 1) [11].

The scale comprises a row of five faces ranging from 'relaxed' to 'very worried' in combination with a visual analogue scale of 0–10. Each child was asked to point



Fig. 1. A modified version of the self-report Faces Scale by LeBaron and Zeltzer [11]

to the face or choose the number which most closely depicted its state of anxiety.

The present study investigated two physiological objective parameters of stress – heart rate and oxygen saturation, measured with a mobile pulse oximeter (CMS50F, CONTEC), placed on the index finger of the left hand [12]. Throughout the whole procedure of dental visit, data were recorded and analyzed by a specially developed digital processing and graphic visualization software SPO2 Review V1.2 rel.

Data analysis. The obtained data were tabulated and subjected to statistical analysis using SPSS version 21.0. Differences were considered statistically significant at a level of $p < 0.05$. Independent sample t -test, paired t -test and non-parametric analysis of variance (ANOVA) were applied for data analysis.

The required number of patients is calculated based on a micro-sample at an accepted level of significance ($p < 0.05$) and a maximum permissible error $\alpha < 0.05$ and $\beta < 0.2$. The intention-to-treat concept is chosen as a statistical approach for data analysis.

Results. Before the dental visit, the self-reported levels of dental anxiety varied from 3.23 ± 2.36 to 4.48 ± 3.67 and the mean heart rate – from 92.45 ± 29.69 to 97.71 ± 15.55 bpm (beats per minute). One-Way ANOVA analysis showed no statistically significant difference in both subjective and objective initial anxiety levels between the four investigated subgroups ($p > 0.05$).

Evaluation of the influence of the preventive procedure on dental anxiety. The division of the treatment into two subsequent dental visits, based on the concept of the BMT Latent inhibition, allowed us to investigate the influence of one of the most effective preventive measures – sealant application, on dental anxiety. In the rotary experimental subgroup (conventional protocol of sealant application was applied) the mean heart rate (during the whole procedure) was 98.77 ± 12.38 bpm and the level of self-reported dental anxiety (at the end of the procedure) was 0.74 ± 1.46 . These values were 96.20 ± 12.27 bpm and 0.77 ± 1.41 , respectively, in the laser experimental subgroup (in this group laser conditioning of the enamel was performed before the conventional protocol of sealant application). These results are within the physiologically normal range associated with the age of middle childhood and indicate that the preventive procedures did not provoke dental anxiety and were well-accepted by children in the dental environment [13].

An additional analysis of the results concerning the dynamics of the physio-

logical stress indicator as well as the subjective self-reported dental anxiety during the preventive interventions showed no significant differences between two experimental subgroups (III and IV) ($p > 0.05$). Consequently, the use of Er:YAG laser before sealant application, aiming for an increased bond strength between the sealant and enamel surface, in the laser experimental subgroup (III) did not affect 6–12-years-old children's dental anxiety and was well-accepted by children in the dental environment.

As to the subjective evaluation of dental anxiety, the results showed that in both experimental subgroups at the beginning of the first dental visit children were more anxious. After the end of the oral hygiene and sealant application, they reported they were less anxious, and it helped them to feel calm for the second dental visit. As a result of the technique, Latent inhibition starting with a non-treatment visit, a significantly lower degree of dental anxiety was found at the end of the first dental visit compared to the anxiety levels during the second visit of each experimental subgroup of participants ($p < 0.001$), (Table 2).

Comparison of the initial and final objective and subjective stress parameters between the four subgroups during caries removal. In the treatment of dental caries, the results demonstrated a statistically significant reduction in the mean heart rate and self-reported anxiety scores when Er:YAG laser caries removal was used in combination with Latent inhibition as an anxiety-management strategy.

One-Way ANOVA analysis was used to indicate the statistically significant differences for both subjective and objective anxiety levels during dental treatment at the end of the dental visit between the four investigated subgroups in favour of group III (behaviour guidance strategy + Laser excavation), ($p < 0.001$). The combination of Er:YAG laser caries removal and child-management technique was found to be the most effective in reducing the anxiety ($p < 0.001$) followed by the combination of conventional rotary treatment and BMT ($p < 0.01$) and then the single-use of Er:YAG laser ($p < 0.05$). The least efficacy was seen in the conventional rotary treatment group (single use of CRI for caries removal without BMT), ($p > 0.05$), (Table 3). There is no statistically significant difference in the oxygen saturation levels between the four groups ($p > 0.05$), (Table 3).

Discussion. The age group of the selected patients in the present study ranged from 6 to 12 years, the so-called period of middle childhood, is usually characterized by defiant or uncooperative behaviour which is difficult to manage [14]. Besides, this stage is associated with significant changes in the sense of identity, individuality and self-confidence within the child [15]. Therefore, the investigated age period is suitable for testing and introducing the new laser technology as an alternative caries treatment method to children [16].

To choose an appropriate behaviour guidance strategy and to evaluate the effect of its use, paediatric dentists take advantage of different methods for anxiety assessment in a dental setting. The Faces Scale by LeBaron, used for evaluation of

T a b l e 2

Comparison of the mean dental anxiety of the patients in the two subgroups before and after the dental visit (subjective evaluation)

Subgroup	First visit		Second visit		I ₁ vs I ₂ <i>p</i>	I ₁ vs II ₁ <i>p</i>	II ₁ vs II ₂ <i>p</i>	I ₁ vs II ₂ <i>p</i>	II ₁ vs II ₂ <i>p</i>
	Start (I ₁)	End (I ₂)	Start (II ₁)	End (II ₂)					
Laser experimental	3.97 ± 3.03	0.77 ± 1.41	1.26 ± 2.24	0.29 ± 0.90	0.000	0.000	0.026	0.000	0.049
Rotary experimental	3.23 ± 2.36	0.74 ± 1.46	1.84 ± 1.28	0.77 ± 1.28	0.000	0.003	0.011	0.000	0.904

T a b l e 3

Comparison of the mean dental anxiety of the patients in four subgroups during dental treatment (objective evaluation) and after the dental visit (subjective evaluation)

Method and moment of anxiety assessment	Subgroup	Number of patients, <i>N</i>	Anxiety score, mean ± SD	<i>F</i>	<i>p</i>
Subjective evaluation (after the dental visit)	Laser control (I)	31	1.55 ± 2.42	11.86	< 0.001
	Rotary control (II)	31	3.03 ± 2.59		
	Laser experimental (III)	32	0.29 ± 0.90		
	Rotary experimental (IV)	32	0.77 ± 1.28		
	Total	126	1.41 ± 2.18		
Objective evaluation (during cavity preparation)	Laser control (I)	31	103.26 ± 13.48	10.44	< 0.001
	Rotary control (II)	31	109.74 ± 6.65		
	Laser experimental (III)	32	94.35 ± 12.84		
	Rotary experimental (IV)	32	99.94 ± 8.36		
	Total	126	101.82 ± 12.29		
Oxygen saturation (during cavity preparation)	Laser control (I)	31	98.42 ± 12.13	2.33	> 0.05
	Rotary control (II)	31	98.21 ± 9.07		
	Laser experimental (III)	32	98.04 ± 10.76		
	Rotary experimental (IV)	32	98.17 ± 7.97		
	Total	126	98.21 ± 9.98		

subjective anxiety in the present study, offers a simple, quick, efficient evaluation of anxiety for a paediatric dental patient and is classified as ‘well-established’ [11]. Numerous investigations report that anxiety during dental treatment can significantly affect the heart rate while the oxygen saturation is maintained at a steady constant level [17]. Thus, in the present study, a finger pulse oximeter was used as an objective measure for anxiety levels as the most acceptable method for measurement of physiological changes presenting continuous percentage measurements of a patient’s heart rate [17].

The observations of our research indicated that the combination of Er:YAG laser with BMT Latent inhibition (group III) was found to be the most effective among the four investigated groups in the reduction of anxiety during dental treatment among 6–12-year-old children. The mean differences of the changes in the heart rate and subjective anxiety between the four investigated groups were statistically significant.

The data obtained from the present study are in line with the results of several significant studies that demonstrate a reduction of anxiety of paediatric dental patients on each subsequent dental visit when gradual exposure as a BMT was used. Another important factor that can result in better adaptation and positive effect on dental anxiety over the long term in children is the first dental visit being a non-invasive one – for example, an oral examination or preventive procedure [18]. The present findings contradict those of past studies which showed no change of dental anxiety in a series of dental visits [19]. The protocols of the investigations, different scales for self-assessment and their application only at the end of the appointment have been reported to be possible reasons.

Besides the BMT, the interpretation of our results should also take into consideration all possible advantages of the used treatment method – laser technique. Laser as new technology have a direct impact on paediatric patients and reduce the level of anxiety significantly. Also, it substitutes the conventional rotary burr – the most stressful and feared factor in children’s perception of a dental visit [3,5]. The results of the current study were also in accordance with many previous studies which reported the successful application of Er:YAG lasers in paediatric dentistry [3].

The investigated combination represents an adaptation of the existing old BMT to the new Er:YAG laser technology. Although it is time-consuming, requires attention to detail, more efforts and special equipment in the dental office, the current data obtained show promising opportunities in the treatment of anxious patients of the investigated age group. The simultaneous influence on several areas of the so-called Five Areas model of Cognitive Behavioural Therapy explains how the highest efficiency of the combined use of the Er:YAG laser and the Latent inhibition technique in the reduction of dental anxiety is probably achieved [20].

An additional detailed statistical analysis, Independent *t*-test, comparing the mean heart rate and self-reported anxiety in subgroup I (laser caries treatment

alone) and IV (combination of the rotary instrument with BMT Latent inhibition) showed no significant difference between two subgroups ($p > 0.05$). These present results demonstrate that the Er:YAG laser application alone is equivalent to the combined use of CRI and Latent inhibition in paediatric patients. The lack of significant difference allows their equal application as a treatment method according to the technical skills of the paediatric dentist and the equipment in the dental office. No previous reports on the efficacy of the single-use of laser technology versus the combination of a BMT and CRI were retrieved despite its importance in the treatment of anxious patients.

Due to the numerous advantages of Er:YAG lasers, modern paediatric dentistry involves their use in routine daily practice [3,5]. Thus, future studies should be conducted to investigate the implementation of new laser technology running parallel to the old well-known techniques.

Conclusion. Paediatric dentists treat anxious children in their daily work life trying to provide adequate dental care.

The data obtained in the present study stress the effective combination of introductory non-invasive preventive procedures and the application of Er:YAG laser as an alternative method for caries removal.

The approach should be individualized, depending on the level of each patient's dental anxiety, time availability, the opportunity for subsequent dental visits, indications for preventive procedures, economic factors, etc.

In the current study Er:YAG laser alone showed an advantage over the conventional method and equivalent effect to the combined use of CRI and BMT.

Therefore, it is considered a promising and reliable 'atraumatic' opportunity for the treatment of cavitated carious lesions and preventive procedures in children.

REFERENCES

- [1] FRENCKEN J. E., M. C. PETERS, D. J. MANTON et al. (2012) Minimal intervention dentistry for managing dental caries – a review: report of a FDI task group, *Int. Dent. J.*, **62**(5), 223–243.
- [2] HMUD R., L. J. WALSH (2007) Dental anxiety: causes, complications and management approaches, *J. Minim. Interv. Dent.*, **2**(1), Corpus ID: 45822259.
- [3] PAGANO S., G. LOMBARDO, M. ORSO et al. (2020) Lasers to prevent dental caries: a systematic review, *BMJ open*, **10**(10), e038638.
- [4] KUMAR G., F. REHMAN, V. CHATURVEDY (2017) Soft Tissue Applications of Er, Cr:YSGG Laser in Pediatric Dentistry, *Int. J. Clin. Pediatr. Dent.*, **10**(2), 188–192.
- [5] American Academy of Pediatric Dentistry (2020) Policy on the use of lasers for pediatric dental patients, Chicago, Ill: American Academy of Pediatric Dentistry, 116–118.

- [6] BULDUR B. (2019) Behavior Management in Pediatric Dentistry: An Overview and Interpretation, *PBOCI*, **19**(1), 4649.
- [7] KHANDELWAL M., R. M. SHETTY, S. RATH (2019) Effectiveness of Distraction Techniques in Managing Pediatric Dental Patients, *Int. J. Clin. Pediatr. Dent.*, **12**(1), 18–24.
- [8] GUNASEKARAN G., M. RAMAKRISHNAN (2020) Evaluation of factors affecting the behaviour of uncooperative pedodontic patients, *PJAEE*, **17**(7), 2027–2038.
- [9] SUBRAMANIAM P., M. HAQH, M. GUPTA (2020) Assessment of trait and state anxiety in 3–6-year old children during sequential phases of dental treatment, *Contemp. Pediatr. Dent.*, **1**(1), 22–32.
- [10] ISMAIL A. I., W. SOHN, M. TELLEZ et al. (2007) The International Caries Detection and Assessment System (ICDAS): an integrated system for measuring dental caries, *Community Dent. Oral Epidemiol.*, **35**(3), 170–178.
- [11] LEBARON S., L. ZELTZER (1984) Assessment of acute pain and anxiety in children and adolescents by self-reports, observer reports, and a behaviour checklist, *J. Consult. Clin. Psychol.*, **52**(5), 729–738.
- [12] SONG J. S., H. C. CHUNG, S. SOHN, Y. J. KIM (2020) Effects of psychological behaviour management programme on dental fear and anxiety in children: A randomised controlled clinical trial, *Eur. J. Paediatr. Dent.*, **21**(4), 287–291.
- [13] RADHAKRISHNA S., I. SRINIVASAN, J. V. SETTY et al. (2019) Comparison of three behaviour modification techniques for management of anxious children aged 4–8 years, *J. Dent. Anesth. Pain Med.*, **19**(1), 29–36.
- [14] Regulation No 2/04.02.2003 for organization and conduction of preventive examinations and dispensary observation of 0–18 aged insured individuals (2003) *State Gazette*, **16**, 33–40, (in Bulgarian).
- [15] KHANDELWAL M., R. M. SHETTY, S. RATH (2019) Effectiveness of Distraction Techniques in Managing Pediatric Dental Patients, *Int. J. Clin. Pediatr. Dent.*, **12**(1), 18–24.
- [16] ECCLES J. S. (1999) The development of children ages 6 to 14. The Future of children, **9**(2), 30–44.
- [17] ZHU M., H. YU, B. XIE (2020) Experiential learning for children's dental anxiety: a cluster randomized trial, *BMC Oral Health*, **20**(1), 216.
- [18] UMMAT A., S. DEY, A. P. NAYAK et al. (2019) Association between dental fear and anxiety and behavior amongst children during their dental visit, *Biomed. Pharmacol. J.*, **12**(2), <https://doi.org/10.13005/bpj/1716>.
- [19] KOENIGSBERG S. R., R. JOHNSON (1975) Child behavior during three dental visits, *ASDC J. Dent. Child.*, **42**(3), 197–200.
- [20] WILLIAMS C., A. GARLAND (2002) A cognitive-behavioural therapy assessment model for use in everyday clinical practice, *Adv. Psychiatr. Treat.*, **8**(3), 172–179.

*Department of Paediatric Dentistry, Faculty of Dental Medicine,
Medical University – Plovdiv,
3 Hristo Botev Blvd, 4000 Plovdiv, Bulgaria
e-mails: mariya.shindova@gmail.com, abeltcheva@yahoo.com*