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SENSITIVITY EVALUATION OF CARIES REMOVAL IN PRIMARY MOLARS USING AN Er:YAG LASER: A RANDOMIZED SPLIT-MOUTH CLINICAL TRIAL

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ABSTRACT

Objectives: The aim of this study was to evaluate dentin sensitivity in primary molars and the children's preference method employed in selective caries removal. **Materials and Methods:** A randomized controlled clinical trial with a split-mouth design was carried out. The sample was composed of 20 children, in whom 40 primary teeth were randomly divided into two groups according to the selective caries removal method used: (I) Er:YAG laser (250 mJ/4 Hz) and (II) conventional method (bur preparation). Each child underwent both procedures and served as his/her own control. Restorations were performed with composite resin. Dentin sensitivity was evaluated using an analog facial scale and the children's preference method in selective caries removal was evaluated by means an interview. The data were analyzed by Fisher's Test (5%). **Results:** There was statistically significant difference between the selective caries removal and the face indicated by child (p=0.010). The children submitted to selective caries removal using conventional method experienced greater dentin sensitivity in comparison to those submitted to Er:YAG laser. The children's preference by an Er:YAG laser as the method of selective caries removal in a future restorative treatment was of 90%. **Conclusion:** Er:YAG laser promoted a lower sensitivity painful and it was the preference method by most children in selective caries removal when compared to conventional method.

KEYWORDS: Lasers, dental caries, primary tooth, dentin sensitivity, child.

INTRODUCTION

Nonselective removal to hard dentine or complete caries removal is considered overtreatment and no longer advocated.[1] In this treatment only hard dentine is left and the demineralized dentine considered free of bacteria is completely removed.[1] There is a consensus for dentine tissue removal, since in deeper caries lesions, pulpal health should be prioritized and selective removal to soft dentine should be performed.[1,2] The advantages of the incomplete caries removal compared to complete caries removal it is justified by the reduction of the risk of pulp exposure and post-operative pulpal symptoms.[3]

Partial caries removal involves the removal of infected dentin, which is a softened, necrotic and moist tissue that carries a large amount of bacteria.[4-7] The affected dentin maintained on the pulpal and axial walls is capable of remineralization, less disordered, with a small number of bacteria,[5,6] through the tubular sclerosis process and the deposition of tertiary dentin, thus reducing the permeability of the remaining dentin.[5] Some clinical criteria such as, hardness, moisture, color, fluorescence properties, and dye stainability was observed in affected dentin and it is used to distinguish of the infected dentin.[1]

Some methods have been proposed for caries removal as mechanical and chemical-mechanical principles,[8] using no rotatory and rotatory instruments. However, rotatory instruments could cause vibration, pressure, noise, pain, anxiety, stress and fear in children.[9,10] Thus, the laser technology has been proposed for caries removal in primary teeth.

Some studies have showed that the Er:YAG laser can decreased pain and fear in restorative procedures in

pediatric dentistry, since this laser does not generate noise, pressure or vibration of conventional rotary devices and thus require less local infiltrative anesthesia.[9, 11-13] Besides, the use of an Er:YAG laser provides a conservative treatment, increase of enamel microhardness, as well as providing a better surface for adhesive restorative materials.[14-17]

Caries removal using an Er:YAG laser is more accept by patients[18-21] compared to conventional rotary devices, however in the literature there are few clinical reports that evaluated dentine sensitivity[9,18,19], with sparse and inconclusive results.

Therefore, the aim of the present clinical randomized study (split mouth) was to evaluate the tooth sensitivity in primary molars by an analog facial scale and the children's preference method employed by means a interview in selective caries removal using an Er:YAG laser. The null hypothesis to be tested were (I) Er:YAG laser promotes tooth sensitivity in primary molars similar to conventional method in selective caries removal employing an analog facial scale (II) children not had preference by the employed method.

MATERIALS AND METHODS

Experimental Design

The study factor method was employed for selective caries removal using (I) the Er:YAG laser (250 mJ/4 Hz) and (II) conventional method (bur preparation, control) . The experimental samples for the randomized split mouth clinical study consisted of 20 children (n=20) and 40 counterpart primary molars with active caries lesions and cavitation reaching the dentin, located at the occlusal surface (class I). The experimental design used a randomized complete block. The response variables used to test the tooth sensitivity of the selective caries removal were evaluated by means of an analog facial scale and the preference method by means of an interview.

Ethical Aspects

The present study was approved by the Committee of Ethics in Research at the Ribeirão Preto School of Dentistry – USP (2010.1.159.58.3). The children's parents or guardians were informed about the purpose of the study and signed the Terms of Consent agreeing to participate in the research.

Two thousand eight and one hundred children of both genders and between the ages of seven and 10 were examined. Of these, 20 received treatment and were evaluated (11 girls and nine boys) met the inclusion criteria and were accepted to take part in the study.

The CONSORT guide[22] for randomized clinical trials was followed for the study design. Figure 1 represents the CONSORT diagram, which discriminates in detail the recruitment form, allocation, monitoring and analysis of the research subjects.

The diagnosis of active caries lesions was performed, after prophylaxis under adequate illumination, followed by standardized radiographic examination with bitewing radiographs, using positioned (Jon, São Paulo, SP, Brazil) radiographic film #2 (Kodak, New York, NY, USA), with an exposure of 50 kV, 10 mA and 0.6 seconds (Spectro 70X, Dabi Atlante, Ribeirão Preto, SP, Brazil). The radiograph processing was performed automatically (A/T2000 XR, Air Techniques, Melville, New York, NY, USA).

The inclusion criteria for children included the presence of at least two active caries lesions in primary molars (lesion affecting ½ of the dentin on radiographic examination) and located on the occlusal surfaces (Class I) of contralateral primary molars, with vital pulps, positive response to a cold test, absence of spontaneous pain and absence of periapical lesions (radiographic examination).

Children were excluded if they clinically presented tooth pain, spontaneous sensitivity, fistulas, swelling, or mobility not compatible with the root rizolisis stage or if they radiographically presented with furcal or periapical radiolucencies, increased periodontal space or internal/external dental reabsorption.

Selective caries removal

Subject randomization was conducted using a computer spreadsheet. With the aid of a random number generator available at http://randomnumbergenerator.intemodino.com/pt/, the selected children had their names numbered to order their treatment. Teeth were randomly assigned to the experimental group (Er:YAG laser) or the control group (Conventional method) by coin toss. The different methods of selective caries removal were performed in separate sessions.

The color of the composite resin employed at the cavity restorations (Filtek Z350; 3M ESPE, São Paulo, SP, Brazil) was selected using the Vita color scale (Wilcos of Brazil, Industry and Commerce Ltda, Petrópolis, RJ, Brazil), being chosen the hue, chroma and brightness.

The EMLA topical anesthetics (Astrazeneca Laboratory, Cotia, SP, Brazil) was applied through flexible shaft cotton tip (Cotonete®, Johnson & Johnson, Brazil) at the gingival papilla of primary molars, following absolute isolate of the operative field.[19] The operative field was isolated with a rubber dam (Madeitex, São José dos Campos, SP, Brazil) using clamps #207, #209 or #26 (Duflex, SSWhite, Rio de Janeiro, RJ, Brazil) depending on the dental morphology of each primary molar.

All tooth preparations for both treatments were begun without infiltrative local anesthesia, however children were informed that they could have infiltrative local anesthesia whenever they wanted.[18] After absolute isolation, the selective caries removal was performed.

Each child underwent both procedures and served as his/her own control.

In the experimental group, the access to the caries lesion (removal of the cavosurface enamel) and the selective caries removal was completed with the Er:YAG laser (Fidelis Er III, Fotona, Ljubljana, Slovenia) in the MSP mode, using a pen (R02), at the non-contact mode with focal distance of 7 mm, a pulse energy of 250 mJ, a pulse frequency of 4 Hz,[23] an output beam diameter of 0.9 mm, an energy density of 39 J/cm^2 and under water spray (6 mL/min). Both the patient and the operator wore protective glasses during the laser treatment. Treatment took place in a room specifically prepared for this type of treatment, in accordance with the general guidelines for safe laser application.

In the control group, the selective caries removal was performed using spherical carbide drills #½, #1 and #2 (KG Sorensen, Barueri, SP, Brazil), compatible with the cavity size, mounted in low-speed turbines (Dabi Atlante, Ribeirão Preto, SP, Brazil). When necessary, access to the caries lesion (removal of the cavosurface enamel) was performed using spherical diamond burs #1012 and #1014 (KG Sorensen, Barueri, SP, Brazil), which were also compatible with the cavity and which were mounted in high-speed turbines (Dabi Atlante, Ribeirão Preto, SP, Brazil).

Selective caries removal was initiated in the superficial layer of infected dentin from the surrounding walls of primary molars using either the Er:YAG laser or conventional method. In the pulpal wall the infected dentin was removed and the affected dentin, which is a hardened and dry tissue, resistant to curettage and susceptible to remineralization, was left.[1,6] (figure 2). It was checked with a probe and evaluated based on clinical criteria of consistency and texture.[4]

Only the incomplete removal of the caries tissue from the surrounding walls was verified according to the clinical hardness criteria[6], curettes #11, #11 ½ and #12 (Duflex, SSWhite, Rio de Janeiro, RJ, Brasil) were used to supplement the total caries removal, whenever necessary for both groups.

Sensitivity evaluation

During the selective caries removal in primary molars and prior to the dental restorative procedures, children were instructed to raise a hand, as a signal to stop treatment if exhibit any dental sensitivity during this period.

It was explained in simple language to the children, how they could indicate tooth sensitivity at the analog facial scale. The analog facial scale was exposed at a visible place during all the procedure. Children indicated the degree of tooth sensitivity felt, pointing a face at the analog facial scale during the selective caries removal using an Er:YAG laser or conventional method (Figure 3). The analog facial scale presents four faces, graded according to the pain intensity, from no pain, medium pain, moderate pain to severe pain.[18] If child reported moderate or severe pain, infiltrative local anesthesia was performed immediately. This analog facial scale was made with figures drawn in black on white paper, of 10 cm wide by 28 cm long, and was presented to children without any visual or numerical description.

Restorative Treatment

The cavity was conditioned with 37% phosphoric acid gel for 15 seconds for enamel and seven seconds for dentin[24] and washed with water for one minute. The excess of water was removed with a suction cannula and the cavity was dried with cotton balls. The adhesive system (Adper Single Bond 2 - 3M ESPE, São Paulo, SP, Brazil) was applied in two layers with a disposable applicator (KGBrush, KG Sorensen, Cotia, SP, Brazil) and light cured (Ultralux -750 mw/cm², Dabi Atlante, Ribeirão Preto, SP, Brazil) following the manufacturer's instructions.

For the restoration, the composite resin Filtek Z350 (3M ESPE, São Paulo, SP, Brazil) was applied in small increments with the #½, #1 and #2 spatula of teflon Suprafill (Duflex, SSWhite, Rio de Janeiro, RJ, Brazil) to resin and light cured for 20 seconds, returning the anatomical shape to the teeth.

After the restoration was complete, the isolation was removed and occlusal adjustment was performed with carbon paper (AccuFilm, Parkell, Farmingdale, NY, USA) and diamond finishing burs (KG Sorensen, Cotia, SP, Brazil). The children returned after seven days for the final polishing of the restorations with abrasive tips (Enhance, Dentisply, Petrópolis, RJ, Brazil), mounted in a low-speed turbine (Dabi Atlante, Ribeirão Preto, SP, Brazil).

Evaluation of Treatment Preference

Seven days after the restorative procedures, children showed their choice about the method of selective caries removal answering the following question: If you need to have a tooth prepared in the future which method would you prefer?.[25]

Statistical Analysis

The obtained data were analyzed by the method of contingency table with Fisher's exact test (method of selective caries removal versus face indicated by children), with significance level of 5%, using the software STATA® 12 for Windows (Stata Corp LP, Texas, USA). The preference by the method of selective caries removal was evaluated using the descriptive table.

RESULTS

There was statistically significant difference between the method of selective caries removal and the face indicated by the child (p=0.01), as shown in Table 1.

The children's preference by an Er:YAG laser as the method of selective caries removal, at a restorative treatment in the future, was of 90%, as shown in Table 2.

Table 1: Method of selective caries removal and the face indicated by children at analog facial scale

Face	1	2	3	4	Total
	No pain	Medium pain	Moderate pain	Severe pain	
Conventional method	7 (35%)	5 (25%)	6 (30%)	2 (10%)	20 (100%)
Er:YAG Laser	10 (50%)	9 (45%)	1 (5%)	0 (0%)	20 (100%)
Total	17	14	7	2	40

Pearson chi^2(3) = 7.2437 Pr = 0.065 Fisher´s exact = 0.065.

Table 2: Preference for the method in selective caries removal by the children in a future restorative treatment.

Method of selective caries removal	Total of Children
Er:YAG Laser	18 (90%)
Conventional Method	01 (5%)
No preference	01 (5%)

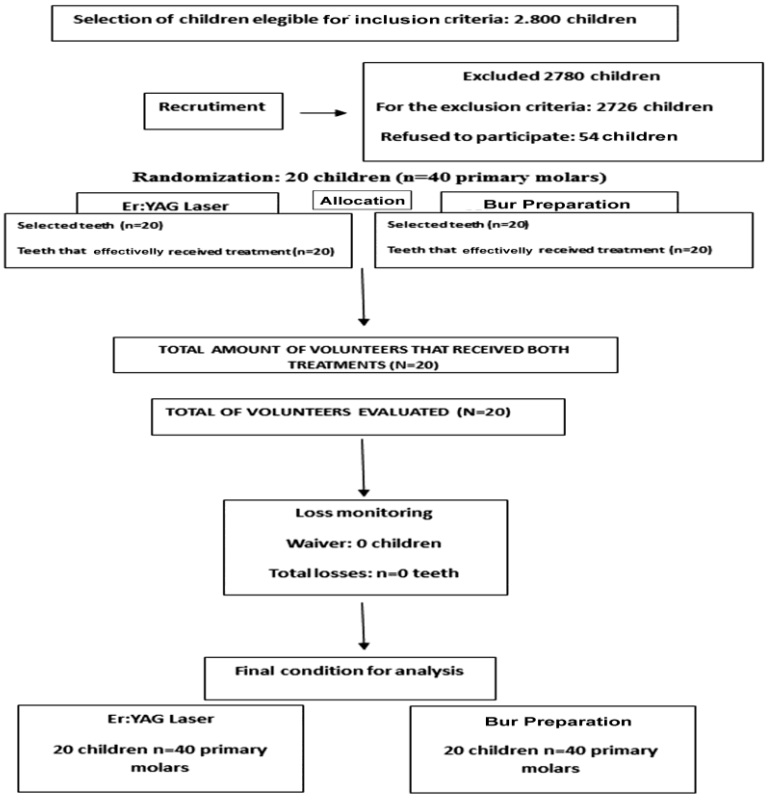

Figure 1: CONSORT schematic explaining the recruitment, allocation, accompaniment and analysis of the research subjects.

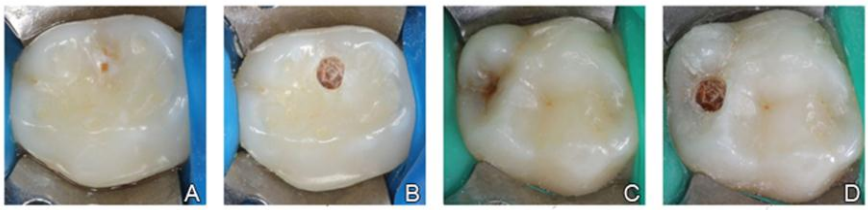

Figure 2: A: Active caries lesion with cavitation reaching dentine located at the occlusal surface at primary molar. B: Cavity aspect after selective caries removal with an Er:YAG laser. C: Active caries lesion with cavitation reaching dentine located at the occlusal surface at primary molar. D: Cavity aspect after selective caries removal with conventional method.

Figure 3: Analog facial scale.

DISCUSSION

The null hypothesis was rejected for the response variable tooth sensitivity. The findings demonstrated that children submitted to selective caries removal with a conventional method (low-speed bur) experienced greater sensitivity in comparison to those submitted to Er:YAG laser. The greater degree of sensitivity in control group may be attributed to effect that burs tend to exert discomfort, vibration and noise, especially among children. Moreover, the use of drill equally removes infected and affected dentin, resulting in excessive loss of healthy tooth structure.[9,10,26] Other studies also related that bur preparation tends to cause pain because to pressure and vibration produced during removal of carious tissue, and it most commonly associated with frightened, cry,[19] body and head movement.[18] It's important to remember in those cases (moderate or severe pain), the treatment was interrupted and concluded after infiltrative local anesthesia.

Er:YAG laser has been used for removal of carious tissue in children with reduction of vibration, noise and pain.[11,12,18,19] So it was more comfortable and effective for removal of carious tissue[9], as observed in this study. After laser treatment occurs a reduction in permeability of dentin, leading an analgesic effect.[27,28] The use of an Er:YAG laser produced anesthetic effect on the tooth, by blocking nerver conduction at Na/k pump and ablating dentinal tubules.[29] This analgesic effect may have contributed to the results found in this study. In selective caries removal using an Er:YAG laser (250 mJ/4 Hz), 95% of children indicated faces 1 or 2, indicating no pain or medium pain, respectively. Only one children needs infiltrative local anesthesia in selective caries removal using an Er:YAG laser, suggesting that Er:YAG laser should be used for selective caries removal in children because its caused decreases sensitivity. Moreover the removal of carious tissue using an Er:YAG laser appeared more conservative than bur preparation, resulting in less dentine tissue removal, which could also justify the lowest sensitivity reported by children.[17]

The clinical success of composite restorations after selective caries removal using an Er:YAG laser are factors of concern dentists. Previous studies have shown that Er:YAG laser is effectiveness in partial caries removal from the pulpal wall of primary teeth[23], beside retention, marginal discoloration, secondary caries and marginal adaptation of restorations was not observed in 1 year of follow-up[23] and 5 year of follow-up[30], demonstrating that the Er: YAG laser can be used in cavity preparations. It is important to know that the effectiveness of the lasers depends on complex interactions such as wavelength, pulse duration, frequency and energy and this characteristics are responsible for the effects produced in irradiated hard dental.[31] The Er:YAG laser parameters chosen in this study were previously used with satisfactory overall result[23], which may also have contributed to the results found.

The null hypothesis was rejected for the response variable evaluation of treatment preference, evaluated seven days after the restorative procedure. Dental caries treatment using an Er:YAG laser in a clinical study (patients aged 15 to 30 years) felt generally safe with laser treatment and were able to relax during the procedure.[34] It may also have been occurred with the children in this study, which justified your preference by selective caries removal using an Er:YAG laser (90%). Similar findings were found by Liu et al.[18], using an Er:YAG laser for caries tissue removal in children, where 95% of them felt more comfortable with laser therapy and 90% would choose the laser as the cavity preparation tool at their next dental visit. The annoying sound of the drill can be terrifying to children and patients become uncomfortable,[18,32] but a masking noise can be used to reduce stress and fear during dental treatment[33], as observed in laser treatment.

The results of this study showed that Er:YAG laser can be used for selective caries removal in children. Dental restorative treatment in children are always more complicated, therefore, pediatric dentistry has a

responsibility to avoid future traumas and the willingness of children to repeat this type of treatment in the future, thus, the technology using laser for caries tissue removal in children promoted lower sensitivity painful.

CONCLUSION

It can be concluded that an Er:YAG laser promoted lower sensitivity painful during selective caries removal and was the preference method by most of children when compared to conventional method. Er:YAG laser should be used to avoid future traumas in dental restorative treatment in children.

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