

The Effect of Erbium, Chromium:Yttrium-Scandium-Gallium-Garnet (Er,Cr:YSGG) Laser Therapy on Pain During Cavity Preparation in Paediatric Dental Patients: A Pilot Study

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Abstract

Introduction: Standard treatment for caries removal and cavity preparation for restorations using mechanical means is often accompanied by fear and pain for the patient. Although the pain may be reduced by local anaesthesia, fear of the needle, noise, and the vibration of mechanical preparation remain a cause of discomfort. Erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser irradiation indicates that pain perception may be reduced relative to that caused by mechanical preparation.

Aim: The aim of this pilot clinical study was to perform a preliminary evaluation of pain perception during cavity preparation comparing the mechanical removal and Er,Cr:YSGG laser removal of caries from enamel and dentine.

Methods: The study sample was ten children aged 7 to 12 years. Half of the preparations were completed by the laser alone and the other half were mechanically prepared. All cavities were restored with light-cured composite resin following the application of acid etch and a bonding agent. The time spent on cavity preparation and the behaviour of the patients during cavity preparation were recorded. Children were instructed to rate their pain on a visual analogue scale. In addition, the patients were asked to decide which was the more uncomfortable form of treatment and the preferred treatment for future caries therapy.

Results: Children showed considerably more body and head movement with the conventional mechanical preparation. The subjects rated the perception of pain lower when the laser technique was used.

Conclusion: In the small number of children studied, the application of the Er,Cr:YSGG laser system was a more comfortable alternative or adjunctive method to conventional mechanical cavity preparation. A further far larger study is necessary to confirm this finding.

Key Words: Er,Cr:YSGG Laser, Cavity Preparation, Pain Perception, Children

Introduction

For several decades, dentists have been using conventional mechanical cutting and drilling systems to remove diseased dental hard tissues and to prepare cavities for restoration. This process is efficient but uncomfortable because of the vibration and loud noises that make the patients anxious. *In vitro*, it has been found that lasers have the ability to remove caries [1,2]. The advantages of decreased discomfort and reduced pain have also drawn numerous researchers to investigate various applications of lasers in dentistry [3-6].

Many different lasers are useful in paediatric dentistry. With the development and introduction of Erbium family lasers, the paediatric dentist has a

safe and efficient laser to treat the hard and soft tissues of the oral cavity. The Erbium laser's shallow depth of tissue penetration, high affinity with water, lack of thermal damage and minimal reflective property make it an ideal laser for paediatric dentistry [7,8].

The erbium, chromium:yttrium-scandium-gallium-garnet, or Er,Cr:YSGG laser of 2780 nm wavelength, using a pulsed-beam system and fibre delivery, has proved to be a valuable tool for ablating enamel and dentine [8]. The laser energy is delivered through a fiberoptic system to a sapphire tip that is bathed in an adjustable mixture of air and water vapour. It generates precise hard-tissue cuts by virtue of laser energy interaction with water at

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the tissue interface and has therefore been termed a hydrokinetic system [9,10]. In addition, in one study pulpal temperature increased by only 2°C when the dentine was irradiated by Er,Cr:YSGG laser [11] and no pulpal inflammatory responses could be identified either immediately or 30 days after laser preparations [12].

Thermal injury to the pulp caused by mechanical preparation results in neurogenic inflammation, giving rise to pain and a hyperaemic increase in pulpal blood flow. Such reactions may be followed by necrosis of the pulp. In contrast, the results of investigations of the reaction of teeth to Er,Cr:YSGG laser irradiation indicate that pain perception may be reduced relative to that caused by mechanical preparation [13]. Because of the advantages of the Erbium lasers for cavity preparation in the treatment of dental caries, they might be especially useful for child patients in paediatric dentistry.

Aims

The aims of this pilot study were to evaluate and compare the pain perception, preparation time and patient perception during cavity preparation between conventional mechanical preparation and Er,Cr:YSGG laser preparation of caries in dental hard tissues.

Methods

Selection of patients

A convenience sample of ten generally healthy children (six male, four female) aged 7 to 12 years participated in the study. These children were patients of the Paediatric Dental Clinic of Marmara University School of Dentistry, Istanbul, Turkey. This study was performed in accordance with the Helsinki Declaration. Informed consent was obtained from the parents of all the children for the procedure of laser treatment. The benefits and possible side effects, such as popping sounds and the smell associated with ablation, had been fully explained.

All patients were randomly selected and had previously accepted treatment without difficulties, i.e., had been co-operative patients. They were selected because they presented with two mandibular posterior carious teeth having the same type of occlusal surface lesion and approximately equal-sized cavities. Periapical radiographs were taken and teeth with caries extending up to the dentino-enamel junction were included. All teeth and surrounding tissues were clinically free of any patho-

logical condition other than dental caries. Teeth found to be associated with any periapical radiolucency were excluded.

Clinical procedure

Cavity preparation was performed in two lower first permanent molar teeth (36, 46) in each patient (a total of 20 teeth) by the same well-trained paediatric dentist. First cavities in the lower left first molars (36s) were prepared by Er,Cr:YSGG laser and then the lower right first molars (46s) were prepared by mechanical means. No local anaesthetic was administered.

For laser preparation, an Er,Cr:YSGG laser (Millennium TM, Biolase Technology, San Clemente, CA, USA) of 2780 nm wavelength was used. The laser energy is delivered through a fibre-optic system to a sapphire tip terminal that is bathed in an adjustable mixture of air and water vapour. During treatment the patient and the dental assistants wore protective eyewear. The treatment followed guidelines for the safe use of lasers.

Cavity preparation with Er,Cr:YSGG laser parameters used in the study was predetermined by manufacturer's instructions, with the power output of 5.5 W with 85% air and 85% water vapour for cutting enamel and 3W with 65% air and 55% water for dentine.

The handpiece was held so that the laser tip was at a 45-degree angle and 1.5 mm from the point of entry. During preparation, the sapphire tip (600 µm) was moved carefully back and forth and up and down to remove the caries.

Cavities prepared by mechanical means involved the use of burs in high- and low-speed water-cooled handpieces. The preparation was carried out under visual control with intermittent testing of the hardness of the remaining hard tissue by means of a dental probe. All cavities were restored with light-cured composite resin following the application of acid etch and a bonding agent.

Evaluation

The time spent on cavity preparation was recorded using a stopwatch, starting with the first contact to tooth until the last contact with the preparation.

Immediately following treatment, by laser or mechanical means, each child was instructed to rate sensitivity (pain) during treatment on a visual analogue scale (VAS) (*Figure 1*). In addition, the children were asked to decide which was the more

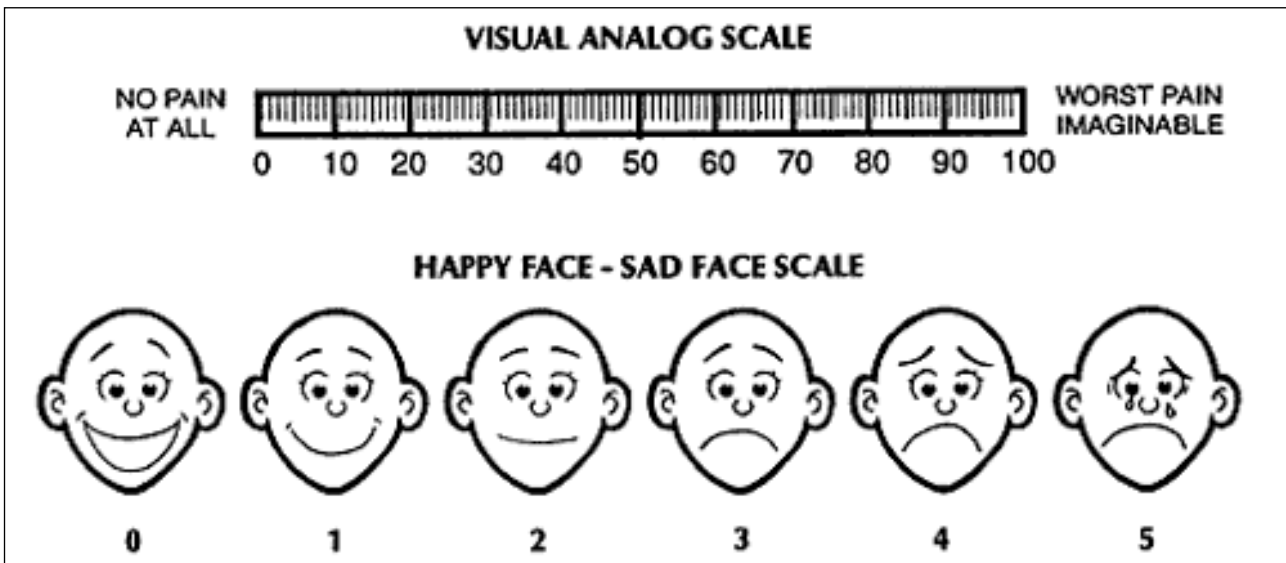


Figure 1. The visual analogue scale used for pain perception.

uncomfortable form of treatment and the preferred treatment for future caries therapy.

Data analysis

Data were collected and evaluated using statistical software (Statistical Package for the Social Sciences for Windows Version 20.0; SPSS Inc, Chicago, IL, USA). Percentage arithmetic mean value was used for statistical analysis due to the small number of subjects.

Results

Preparation time

Within the predetermined parameters, the preparation time ranged from 2 to 11.2 minutes. The mean time for preparation by laser was 7.4 minutes compared to 3.7 minutes for the mechanical means (Table 1). The laser preparation therefore required more than double the time than the mechanical preparation.

Table 1. The range of time taken and mean time for laser and conventional cavity preparation

Treatment duration (minutes)	Min	Max	Mean
Laser application	4.2	11.2	7.4
Mechanical preparation	2.0	5.6	3.7

Pain perception

A VAS from 0 to 100 points was used to assess the pain subjectively. Each patient scored pain intensity after laser and mechanical preparation. There

was a notable difference between two preparations, with mean VAS scores of 23 for laser and 71 for mechanical preparation.

Patient perception

During cavity preparation, seven (70%) of the children considered laser preparations to be more comfortable compared to three (30%) during mechanical preparation. Reasons for discomfort during laser treatment were mostly reported as pain and bad smell. During the conventional mechanical preparation, the children also showed much more body and head movement compared with during laser preparation.

Discussion

Dentists have sought various alternative methods for preparing cavities in the hope of finding a more acceptable instrument without the negative aspects arising from use of the traditional bur. Laser systems have been a prime potential alternative and are now being widely used in soft-tissue and hard-tissue surgery in adults and paediatric patients [3,14-16].

The Er,Cr:YSGG laser has gained popularity because of its mechanism of action. It has been reported in previous studies that the Er,Cr:YSGG laser is considered potentially to be ideal for caries removal and cavity preparation in paediatric dentistry [17-19]. The children are comfortable, feel no vibratory sensation, and experience no contact between tooth and the fiberoptic tip. The use of a non-contact tip with water spray avoids generating an excessive amount of heat and pain during laser application [20].

In the current study, although the number of patients was too small for statistical analysis, there was a difference in the patient perception between laser and mechanical preparation. Pain assessment by the children using the VAS showed mean VAS scores of 23 for the laser and 71 for mechanical preparation. These results were similar to those from a study that was performed in 2006; it evaluated patient sensitivity and acceptance together with the efficiency of Er:YAG laser preparation in children, and compared these with the conventional drill method [5]. That study reported that 82.5% of children felt no pain at all with the laser preparation.

The current study was a small pilot study using a convenience sample of children. Therefore, the results cannot be used to make general statements concerning the pain perception of all children. However, of interest, the data do support available findings that children may prefer laser preparation for further caries treatment. An earlier study, which evaluated patients' responses during caries therapy by using Er:YAG laser, found that 80% of the patients rated the conventional preparation as more uncomfortable than the laser treatment and 82% of the patients indicated that they would prefer the laser preparation for further caries treatment [4].

An Italian study evaluated the Er,Cr:YSGG laser and Er:YAG laser therapy efficacy in paediatric dentistry and assessed the subjective tolerance and acceptance of therapy in children needing both dental and soft-tissue treatments [20]. The results were that the success rate was 90% for hard tissue and 63% for soft tissue and, for a total 100 treatments, the acceptance was 75% [20]. These findings are dissimilar to those of an earlier study in Scotland, which was a randomised controlled trial [21]. Its results indicated that patients aged > or = 10 years preferred laser treatment, whereas patients 10 years old, who were assessed using a simplified pictorial questionnaire, did not show a significant preference for laser or conventional treatment [21].

There are still some problems limiting lasers' clinical application, such as longer preparation time compared to the use of a conventional bur [4,22]. The analysis of preparation time in the current study demonstrated that with the laser, on average nearly twice the time was needed compared to the conventional procedure (7.4 min vs. 3.7 min). The difference in duration between laser and mechanical preparation is mainly due to the amount of sound enamel that has to be removed. Using higher pulse energies or repetition rates, the laser ablation speed could be increased,

but this might also influence safety or the children's response. For children, treatment time is not the primary concern, and pain is the most important factor causing uncooperative behaviour.

The results of the present study clearly demonstrated that 70% of the children considered laser preparations to be comfortable compared to 30% during mechanical preparation. It has been suggested that noise from the conventional turbine was an important factor that induces dental phobia in clinical treatment [22]. Reasons for discomfort during laser treatment were mostly reported to be pain and bad smell.

In summary, the results from this pilot study in Turkey were encouraging and indicate the need for further and larger clinical studies, which should compare the Er,Cr:YSGG laser and the mechanical bur in a clinical trial for a longer observation period and with more patients.

Conclusions

In this pilot study:

- The application of the Er,Cr:YSGG laser system was a more comfortable alternative or adjunctive method to conventional mechanical cavity preparation.
- Patients indicated that they would prefer the Er,Cr:YSGG laser preparation for further caries treatment.
- The use of lasers, in general, and the Er,Cr:YSGG laser in particular, would be a useful alternative method for cavity preparations in children.

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Contributions of each author

- FE, BA and FE designed the study, performed the clinical application of the study, and wrote the paper.
- IT drafted the study and reviewed the manuscript.
- All authors read and approved the final manuscript.

Statement of conflict of interest

The authors declare that there is no conflict of interests.

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