REVIEW ARTICLE

Lasers for Prevention of White Spot Lesion: A Scoping Review

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ABSTRACT

Lasers have been identified as one of the preventive tools that can be utilised to prevent white spot lesion in orthodontic practice. The aim of this scoping review was to evaluate the current scientific literature on the use of lasers specifically to prevent white spot lesion in orthodontic cases. Search was performed in PubMed, Web of Science, Scopus and EBSCO databases from the past ten years. The records obtained were peruse considering specific inclusion and exclusion criteria. From the total of 1123 studies that were evaluated, 68 papers were included for this review. A variety of laser types has been reported including Er;YAG, Er,Cr:YSGG, Argon and CO_2 lasers. CO_2 laser has a good number of evidence of it's positive result and can be suggested to be use in clinical practise. However, since most data for the other type of lasers were derived from in vitro studies, they must be interpreted with care. Randomised clinical trials would be beneficial to give more meaningful evidence for clinicians to adopt lasers in their practice.

Keywords: Laser, White spot lesion, Orthodontics

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INTRODUCTION

White spot lesion occurs when there is demineralisation of the enamel surface. The expression of a chalky white spot on the tooth is the initial sign of carious lesion. 23.4% of orthodontic patients with fixed appliance would develop white spot lesion (1).

There are two main approaches in preventing decalcification during orthodontic treatment. It is either by removal of causative factors (e.g., dietary sugars, plaque formation or adhesion) or by tackling the susceptibility of enamel surface towards demineralisation. Conventional prevention of white spot lesion was mostly done by maintaining optimal oral hygiene, the use of fluoride mouth rinses (2) or the use of professionally applied adjunct such as topical fluoride.
A review on the use of laser in Paediatric Dentistry has concluded that there is a lack of sufficient evidence on the clinical application of laser in dentistry although it is readily apparent of the success of paediatric laser usages in soft tissue surgery (3).

There have been several reported investigations regarding the use of laser to prevent white spot lesion. However, it is not a routine practice in clinical setting. This paper aims to review the available scientific evidence regarding the use of laser in preventing enamel decalcification during orthodontic treatment.

METHODS

This is a scoping review conducted by using a framework that was suggested by Arksey and O'Malley (4). The search was conducted by using four databases;

- PubMed
- Scopus
- Web of Science and
- EBSCO.

Criteria that have been included in this review were articles written in English published from January 2008 until December 2018. Articles associated with the use of laser for prevention of white spot lesion were searched from the databases. Case reports and full research articles were included except abstract for scientific presentation and review papers. The search terms that were used in the search engine were laser, prevention, enamel demineralisation or white spot lesion.

The search resulted in 1123 initial records (Fig. 1) from all four databases after duplicates were removed. Abstracts of these records were screened, and 1053 records were excluded. 70 full-text articles were then assessed for eligibility, and two has to be excluded as one paper was an in vitro study to assess laser used in treating initial demineralisation while another paper was an abstract for a proceeding, whereby no full-text article was available. Thus, a total number of 68 full-text

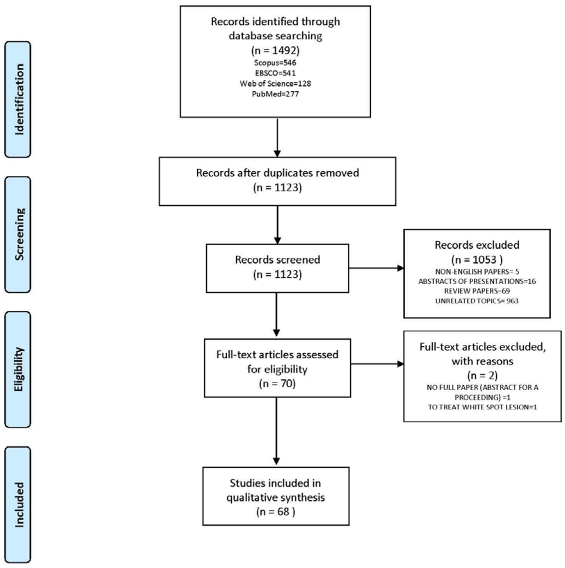

Figure 1: PRISMA flow chart

articles were assessed and included in this qualitative synthesis (Table I).

DISCUSSION

68 research articles were assessed from the year 2008 until 2018 (Fig. 2)(5-73). For the past 10 years, the majority of studies regarding lasers in preventing white spot lesion were in vitro studies, five in vivo studies were found while only two clinical trials were done in this subject.

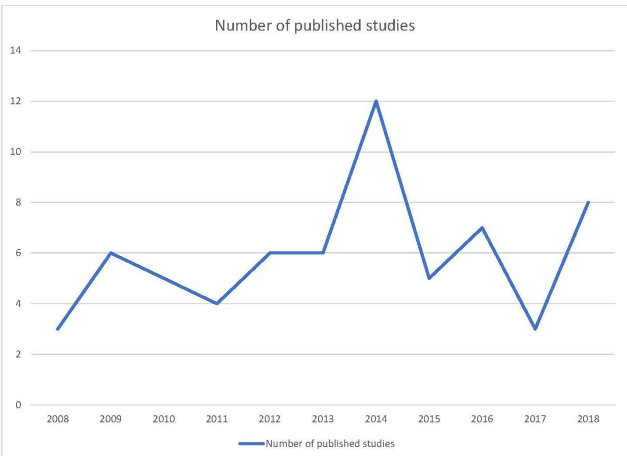

Figure 2: Studies grouped by year of publication

Four in vivo studies lased teeth that would be extracted from patient's mouth (30, 51, 52, 72) while one study uniquely inserted a bovine enamel slab using a palatal appliance inside volunteer's mouth (61). All five in vivo studies indicate inhibition of demineralisation.

Lasers used in studies associated with white spot lesion prevention were mostly CO_2, followed by Er:YAG, Nd:YAG and Er,Cr:YSGG (Fig. 3). Diode, argon and

Table I: Characteristics of included study

No	First Author	Year	Study Design	Type of Laser
1	Afsheen, S	2008	In Vitro	Nd:YAG
2	Ana, P.A	2012	In Vitro	Er,Cr:YSGG
3	Ana, P.A	2014	In Vitro	Nd: YAG Er, CR: YSGG
4	Anaraki, S.N	2012	In Vitro	CO_2 Er,Cr: YSGG
5	Azevedo	2012	In Vitro	Nd: YAG
6	Azevedo	2012	In Vitro	Er: YAG
7	BahroloIoomi	2015	In Vitro	Diode
8	Banda, N.R	2011	In Vitro	Nd: YAG
9	Bedini, R	2010	In Vitro	Nd: YAG
10	Behroozibakhsh, M.	2018	In Vitro	Er:YAG
11	Belcheva, A	2018	In Vitro	CO_2
12	Bevil6cqua, F. M.	2008	In Vitro	Er:YAG
13	Chand, B.R	2016	In Vitro	Nd:YAG Diode
14	Chokhachi Zadeh Moghad-am, N.	2018	In Vitro	Diode
15	Correa-Afonso, A. M.	2010	In Vitro	Er:YAG
16	Correa-Afonso, A. M.	2012	In Vitro	CO_2
17	De Freitas, P. M.	2010	In Vitro	Er,Cr:YSGG
18	De Sant'Anna, G. R.	2009	In Vitro	Diode
19	De Souza-E-Silva, C. M.	2013	In Vitro	CO_2
20	Devados, B. R.	2009	In Vitro	Argon
21	Dнaz-Monroy, J. M.	2014	In Vitro	Er:YAG
22	Esteves-Oliveira, M.	2009	In Vitro	CO_2
23	Fekrazad, R.	2014	In Vitro	Er, Cr:YSGG
24	Fornaini, C.	2014	In Vitro	Er: YAG
25	Geraldo-Martins, V. R.	2013	In Vitro	Er, Cr:YSGG
26	Kaur, T	2017	In Vivo	Er, Cr:YSGG CO_2
27	Kim, J.W	2016	In Vitro	CO_2
28	Kim, J.W	2017	In Vitro	CO_2
29	Kumar, P.	2016	In Vitro	Er,Cr:YSGG
30	Liu, Y	2013	In Vitro	Er:YAG
31	Mahmoudzadeh, M.	2018	In Vitro	CO_2
32	Manuela Dнaz-Monroy, J.	2014	In Vitro	Er:YAG
33	Mathew, Anju	2013	In Vitro	Er:YAG CO_2
34	Miresmaeili, A.	2014	Single-blind inter-ventional clinical trial	CO_2
35	Miresmaeili, Amirfarhang	2014	In vitro	Argon
36	Mocuţa, D.	2016	In Vitro	Er:YAG
37	Moghadam, N. C. Z.	2018	In Vitro	Diode
38	Moslemi, M.	2009	In Vitro	Er;Cr;YSGG
39	Nair, A. S.	2016	In Vitro	Er:YAG
40	Nakagaki, S.	2015	In Vitro	CO_2
41	Nogueira, R. D.	2017	In Vitro	Er,Cr;YSGG Er:YAG Diode
42	Noureldin, A.	2016	In Vitro	CO_2
43	Nozari, A.	2018	In Vitro	CO_2
44	Paulos, R. S.	2017	In Vitro	CO_2 Nd:YAG
45	Raghis, T.	2018	Randomised clini-cal trial	CO_2
46	Raucci Neto, W.	2015	In-Vivo	Nd:YAG
47	Rechmann, P.	2011	In-Vivo	CO_2

continue...........

Table I: Characteristics of included study (continued.....)

No	First Author	Year	Study Design	Type of Laser
48	Rechmann, P.	2016	In Vitro	CO_2
49	Reddy Banda, N.	2011	In Vitro	Nd-YAG
50	Rodrнguez-Vilchis, L. E.	2010	In Vitro	Er:YAG
51	Rodrнguez-Vilchis, L. E.	2011	In Vitro	Er:YAG
52	Seino, P. Y.	2015	In Vitro	CO_2 Nd:YAG
53	Shahabi, Sima	2016	In Vitro	Nd:YAG Er:YAG
54	Sharma, S.	2016	In Vitro	Aluminum gallium arsenide
55	Souza-Gabriel, A.	2010	In Vitro	CO_2
56	Souza-Gabriel, A. E.	2015	In Vivo	CO_2
57	Stangler, L. P.	2013	In Vitro	CO_2
58	Steiner-Oliveira, C.	2008	In Vitro	CO_2
59	Subramaniam, P.	2014	In Vitro	Er,Cr;YSGG
60	Tavares, J. G.	2012	In Vitro	Argon Nd:YAG
61	Ulkur, F.	2014	In Vitro	Er:YAG
62	Vieira, K. A.	2015	In Vitro	CO_2
63	Wen, X.	2014	In Vitro	Nd:YAG
64	Yassaei, Sogra	2014	In Vitro	Er:YAG
65	Zadeh Moghadam, N. C.	2018	In Vitro	Diode
66	Zamudio-Ortega, C. M.	2014	In Vitro	Er:YAG
67	Zezell, D. M.	2009	In Vivo	Nd:YAG
68	Ziglo, M. J.	2009	In Vitro	Argon

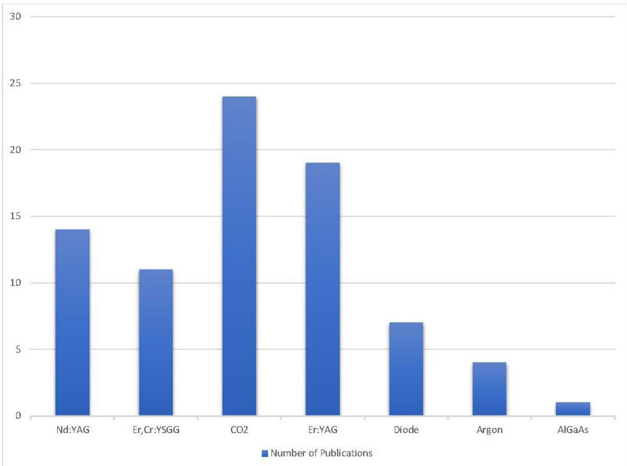

Figure 3: Types of laser according to number of papers published

aluminium gallium arsenide (AlGaAs) were the least reported type of laser in the literature. Nine out of 68 studies compared two or three different lasers together to assess which type of laser would give a better acid resistance outcome. 59 other papers mostly studied one type of laser, either with different parameters or comparing the specific type of laser with conventional preventive tool mainly used in clinical practice such as topical fluoride.

The only two available clinical trials found in the literature assessed CO_2 laser in orthodontic patients treated with fixed appliances.In the first trial, CO_2 lased enamel surface was found to be significantly micro hardened compared to control after two months of intervention (39). However, formation of white spot lesion was difficult to be assessed as the tested teeth were extracted two months after being lased to perform microhardness testing. The other clinical trial was a two-arm, split-mouth randomised clinical trial whereby the primary outcome was the diagnosis of white spot lesion in vivo up until six months into the trial. This study has shown significant clinical and statistical differences in the presence and extent of white spot lesion between the laser treated group and the control group. CO_2 laser was shown to have an inhibitory effect towards demineralisation of enamel adjacent to orthodontic brackets (50). More clinical studies looking at the long term effect of laser usage and the effect of different type of laser is obviously needed within this field.

Experimental laboratory studies were mostly done to assess acid resistance via morphological and surface change assessment, assessment of chemical changes, quantification of mineral content, and microhardness testing. Samples used were mostly permanent human teeth or deciduous teeth. Bovine enamels were the main replacement for human samples as it was considered to be an acceptable replacement for research purposes (60).

Content of enamel after acid challenges were assessed for changes. A variety of result were observed depending on the type of lasers that were being used. There were no significant changes seen in the organic and inorganic content of enamel when it was lased with Er,CR:YSGG prior to acid challenge. However, Nd:YAG promotes loss of carbonate and organic content (6). Another study focusing on a variety of ranges of Nd:YAG laser pulses confirms the finding of the later author regarding changes in the carbonate content. However, fusion of components on the enamel surfaces causes hardening of the surfaces, thus increasing its' acid resistances (5). Enamel surfaces lased with Nd:YAG with 60mJ energy, 10Hz frequency and 0.6W power gives the optimum result for caries prevention and there were no micro-cracks when enamel were tested at the mentioned parameter (13). When Nd:Yag were tested synergistically with fluoride, it gaves a homogenous, confluent surfaces, thus increasing it's microhardness (12). According to authors, this would provide a better protective barrier to caries attack when compared to using Nd:YAG alone. Er:YAG laser may have a good potential to be a preventive agent of demineralisation. It induces crystalline changes mainly due to carbonate reduction and formation of new phases like CaF2(14). Conflicting results on the use of Er:YAG for non-ablative purposes have been found in the literature; 24 shows positive results whilst 13 studies reported negative findings (74). Safe parameters should be properly determined prior to clinical usage as Er:YAG laser also produces cracks and craters that may enhances demineralisation.

CO_2 laser used on enamel surface treated with acidulated phosphate fluoride (APF) gives a better effect in decreasing enamel demineralisation when compared to Er, Cr:YSGG (8). CO_2 used together with APF showed the least diminution in enamel surface microhardness (15). Most authors suggested an excellent outcome when lasers were being used synergistically with topical fluoride while a few have shown that using the laser alone produces better inhibition effect. For example, Er,Cr:YSGG decreases hardness loss with no additive effect when applied together with APF (7). Another interesting study shows the use of laser together with fluoride varnish causes alteration on the surface roughness of the enamel. The pigmented varnish causes an increase in ablative characteristic of Er,Cr: YSGG, Nd:YAG and diode laser making it more susceptible to bacterial adhesion (46).

Most of the scrutinised papers outlined a positive correlation, while only four studies demonstrated the opposite outcome when samples were being lased. Although Er:YAG laser produces beneficial crystalline changes, the morphological transformation may eliminate the positive changes and promotes formation of incipient lesion (14, 56). Another in vitro assessment of Er:YAG laser using microhardness testing and qualitative inspection using scanning electron microscope also found that the demineralisation inhibition of Er:YAG laser was substandard (66). In an in vitro intervention focusing on the effect of laser on primary teeth, the authors suggested that the parameters used in their research were not suitable for prevention of demineralisation in primary teeth. The authors found primary teeth irradiated with Er:YAG has mild to severe damages (71).

CO_2 shows promising results and do have a clinical evidence to back it's use in clinical setting. The main difficulty to perform a good randomised clinical trial in this area are the lack of uniformity in terms of parameters being used in previous experimental studies which is quite exigent to translate into clinical trial fearing detrimental effect towards patient. However, more studies need to be done focusing on the other type of lasers commonly used in dentistry to confirm its clinical efficacy.

CONCLUSION

Majority of the studies included in this review concluded a positive finding with regards to the potential use of lasers as a preventive option in managing white spot lesion. However, most of the studies were in vitro studies using samples of non-vital human or bovine teeth. Thus, interpretation towards clinical practice should be made with caution. More clinical trials in this area are welcome in order to have a better conclusion in terms of which laser would give the best performance, suitable parameters to be use and whether there is still requirement for adjunctive prevention methods such as topical fluoride together with the use of laser.

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