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A laboratory comparative study of bonding strength of posterior composite restorations after classical preparation versus preparation by ER: Yag laser

Claude Nassour
Hama Universitiy, Dentistry Faculty, Department of Endodontics, Syria

Abstract
With the development of use of lasers in dentistry, and submitted suitable wavelengths for safe cutting of the dental tissue, laser was suggested as an important alternative preparation method, that because of its advantages such as (the anesthesia is not often needed, preservation of sound dental tissue and the lack of noise which comes along with high speed handpiece.
The of this study was to evaluate the bonding strength of a posterior composite restorations when two different types of equipment methods were used for preparation of dentin (Erbium-doped yttrium aluminum garnet laser (Er: YAG) and diamond burs. Results showed no significant differences between the levels of bond strengths in bur-cuted dentin and lased dentin, as well as no significant effects due to the difference of restorative material and the bonding system used.

Keywords: laser irradiation, er: yag laser, shear bond strength, rinse adhesive

Introduction
Currently, the recent research in the conservative dentistry is heading to develop alternative preparation methods which are less aggressive than the conventional method; which often leads to more spacious cavities and damage of the neighboring teeth, and lets smear layer on the prepared dental surface which due to weak bonding [1].
Chemo-mechanical Excavation systems, Pepsin-based solution, air abrasion, Ozone system and laser are some of methods which are used as alternative methods to remove dental caries [2]

Caries-Excavation Procedures
A. Conventional Excavation with Burs
1. Carbon-steel or tungsten-carbide burs: Tungsten-carbide burs replaced carbon-steel burs once the process of hardening steel with tungsten carbide was introduced to the dental bur industry. Microscopic tungsten-carbide particles are held together in a matrix of cobalt or nickel at the head (working end) of the bur [3].
The head has typical spiral-like cutting edges with or without additional cross cuts to improve cutting efficiency.
Carbon-steel burs possess the same caries-removing properties as tungsten-carbide burs and are less expensive, but they are much more prone to corrosion and dulling [4].
Tungsten-carbide & carbon - steel burs are considered more effectives method from offering effort & time, therefore it's stayed the most common method at this day [3, 4], In other hand using these burs and applying probe examination by using dental probing to investigate dentin solidity that are remained and to determine the end point of decay removing, removing by these ways are considered oppressive preparation. So we must look for alternative method with less aggressive [5, 6, 7].

2. Polymeric Burs: In an attempt to develop a selective caries-removal rotating instrument a plastic" bur was made of a polyamide/imide (PAI) polymer, possessing slightly lower mechanical properties than sound dentin. However, soon it became clear that if the bur touches sound or caries affected dentin, it quickly becomes dull and produces undesirable vibration, making further cutting impossible. The blade design was developed to remove dentin by locally depressing the carious tissue and pushing it forward along the surface until it ruptures and is carried out of the cavity [7].
With a prototype, single-use instrument, complete removal of carious tissue could be accomplished from extracted teeth when a 1% acid-red-propylene glycol solution was used as caries detector [8].
These burs are known as (Smart burs) and indicated in deep decayed of first & fifth types cases, but we can generally used in all decay lesion [9]. Solidity of these burs makes it selectively in removing dentin decay which reduces from the risk that occurring of pulp exposing, whenever the ordinary burs does not gives these distinguishes [10].

3. Ceramics Burs: These burs are offered at this time which known as (Cera Burs), this is a trade name from (komet - Brass eler; Lem go, Germany) company, which made from (Aluminuim Oxide – Yateria) that are settled in Zurkonium oxide; offered in different sizes [2]. However, an in vitro investigation of the caries-removal efficiency (time consumption for excavation) and efficacy (ability to remove all carious material from the cavity) did not show any significant difference between the ceramic and conventional tungsten-carbide burs these burs [11].

4. Micro preparation Burs: Micro preparation burs are called by (Fissurotomy Burs), from (SS White Burs, Lake-wood, NJ, USA) are designed to exposed & prepared cracks with a little removing for enamel. It's distance between (0.4 - 2.5 mm), ended with a very tapered end from carbide which can remove e (1/6 to 1/10) of the curved insider width [2].

B. Caries Excavation with (chemo -mechanical) method: Solutions that are based on sodium Hypochlorate are primary yield in trying to develop chemical solutions which are affected only on caried dentin. These solution was supported by Aminic Acid solution which contains of (Amine Acid, Sodium chloride & sodium Hydroxide) [12] These dissolution systems for caries removable are advanced beginning in American Market in 1985, as solution called Caridex (National Patent Medical Products; New Brunswick, NJ, USA). This system contain irregular applying of an acid on decay lesion, Where alleged on this solution make a rupture in dentin collagen fibers for this reason it's easily removed [12, 13]. This method reduced the removing of normal dental tissues and pain also, cutting open dentinal tubules and pulp stimulation when we compared with traditional mechanical method. Other than it needed long time and high expensive that made it undesired a lot from practitioners [14].

- Clarisolv System Consist of [15, 16, 17]: Sodium Hypochlorid (0.5%), three Aminic Acids are (Glutamic, lyosin, lycin), jelly material is (caboxy Methyl cellilouse), Sodium Chloride, Saline Solution and Colouring indicator (red).

C. Ultra Sonic Preparation: Ultra Sonic equipments are used through dentistry from many centuries, primitively in management periodontal tissues for scaling, curettage and planning root surface [18]. This system was firstly trading in the conservative treatment to preparing lateral decay lesions with suitable preparing ends [18, 19]. High speed pieces allowed to apply the ultra-sonic heads for many purposes such as decay management, preparing conservative cavities, pulp management, supporting tissues management, fillers sealing and caries prevention, but this method was considered consumptive to the dental tissues [20]. The produced company stipulated that hand-piece vibrations tension in preparing area must be more than 6.5 kH with moving head at ovally movement [21, 22, 23]

Most researches showed that no chemical or structural changes in preparing dentin surface by ultrasonic [22, 24].

D. Caries Removing by Air Abrasion: Air Abrasion systems which followed in preparation are depend on attrition molecules movement energy in dental structure segments. Pure Aluminium oxide molecules (Alumina) are more using materials as abrasion agent [25]. Air Abrasion regards a very suitable way for removing dental pigmentations and caries management in fissures, cracks, shallow cavities, deep decayed and relapsing caries around old restorations [21]. The important advantages of this system that is no needed to anesthesia, the possibility of preparing many caries lesions at different quarters of mouth during one session, and achieve shallow preparations also as (cup-dish) that regard atypical for composite restorations [26].

E. Decay Removing by photo - activated Disinfection (PAD): Preparing systems by photo - activating disinfection (Denfotex Light Systems) are used disinfectant solution applied on deep caries where it can penetrate the loose dentin through 60 seconds. Then lower power of Diode laser applied for one minute by using radiation with wave length equal to 635nm) [27].

F. Decay Removing by Ozone: In a vitro study by (Bleesh Gh) to investigate Ozone effecting on bacteria in the oral cavity, found that Ozone leaded to decrease bacterial oral counting in the studying sample; this is because of Ozone has a powerful oxidized effect that make it able to stop the bacterial efficiency that are responsible on producing dental caries which directly dissolution in water and penetrating cellular bacterial wall causing dying directly [28, 29].

G. Pepsin-based caries excavation: A new experimental gel consisting of pepsin in a phosphoricacid/sodium biphosphate buffer is being considered as an alternative chemo-mechanical caries excavation agent (SFC-VIII, 3M ESPE; Seefeld, Germany)(30).The main advantage of this new enzyme-based solution is that it can be more specific by digesting only denatured collagen (after the triple-helix integrity is lost) than the sodium hypochlorite-based agents**,** the SFC-VIII gel should be used in combination with a prototype plastic instrument having hardness between that of sound and infected dentin. Heavily pigmented, arrested dentin caries is known to be more resistant to pepsin digestion, 109 but this does not seem to present a major drawback to the method [31].

H- Laser Excavation: Kopferam was the first one showed that the provocation renascence phenomena in 1928 [32]. In 1959 Gould is published the term laser and he defined it: exaggeration of light by provocation renascence of radiation to refers to the accuracy of spectrum light that renascence from laser equipments. The word laser it is the abbreviation to the expression of: (Light Amplification by stimulated emission of radiation) [33].

Laser in Dentistry: Stren & Sognnars were the first researchers who used laser on patients in dentistry; they started in 1964 to investigate about the ability of using ruby laser in dentistry [34]. They found deterioration in decreasing of mineralization that occurred solid dental tissues during using this type of laser in comparison when using phosphoric acid [35]. In 1985 Pick, who is a pioneer in oral surgery and Predentics tissues, had published his report about laser Co2 using in gingivectomy which was caused by gingival hypertrophy [36, 37]. Lasers Co2 & Nd YAG & Argon were the first types which used to prepare hard tissues [38], with the development of clinical ambitions of laser it become applied in more dental applications [39, 40]

Table 1: Laser types are used in dentistry

Laser type	Wave Length (nm)	Connecting System
Argon	512-488	Fiberoptic
He: Ne	633	Fiberoptic
Diode	635-670-810	Fiberoptic
ND: YAG	1064	Fiberoptic
Ercr: Ysg	2780	Fiberoptic
Er: YAG	2940	Fiberoptic-Wave to wave arm
Co2	6900-10600	Fiberoptic-Wave to wave arm

These lasers were used in different applications in dentistry: Diagnosis laboratories, restorative and endodontics treatment, in addition to gingival diseases, periodontics, oral surgery and orthodontics, as we shown in the following table [40, 41]

Table 2: Lasers uses in conservative restorative dentistry

Lasers Applications in Restorative Dentistry	CO2	Er: YAG	Er cr: YSGG	Argon	Diode	ND:YA
Enamel Etching		✓	✓			✓
Dental Cavities preparation		✓	✓			✓
Dental filling materials				✓		
Dental Whitening	✓			✓	✓	
Dental sensitive Treatment	✓	✓	✓		✓	✓

(Er: YAG)Laser: Many researches were done to develop the laser applications in dentistry, in beginning laser was applied on loose tissues only [42]. Vahl found during using the ruby laser in deep caries management that produces melting in dentinal tissue [43], Kantola found same results on enamel and dentin through using CO2 laser [42]; while other studies found that if we can't reduce temperatures which occur during caries removable by laser; this heating may lead to hurt the pulp, enamel and dentin; that makes laser incapable to be alternative method in tooth preparation [44, 45].

In 1988, Paghdiwala examined Er: YAG laser as a method to prepare dental tissues, he showed that the cavities which were prepared by laser were free of micro cracks [46]. Hibst was revealed that Er: YAG laser is safety and effectively alternative preparation method if it applied with all tratment recommendations, which recommended using of water spry for some seconds [47]. Although the first production of laser was by Cavo German Company in 1992, the agreement from Food and Drug Administration (FDA) in United Kingdom to use laser on the dental tissue; wasn't occur until 1997 [48, 49]. Later there are two wave lengths are developed from Eberium laser family for clinical using on solid dental tissues: Er: YAG with wavelength 2, 94 micron, and Er: Cr: YSGG with wavelength 2.78 micron [50]. In addition to Stern & Sognnues, Goldman also investigated in 1960; in the efficiency of laser in caries removing and dental cavities preparation in a safety without hurt the adjacent soft tissues or sound dentin and enamel [53].

Er: YAG laser became more common in dental cavities preparation and caries removing after studies which proved its effectiveness in last 1980s [54]. Botto found in her study that using of laser in caries removing didn't caused an appearance of a stain layer, micro cracks or carbonization or melting in any radiant dental structure [55]. Applying of Er: YAG laser on dentin leaves rough and irregular surface with the presence of open dentinal tubes and absence of both stain layer and micro cracks [56, 57]. Eberhard found that Er: YAG laser had a high effectiveness on caries removing and dentin, thus returned to large containing of water and organic materials which present in it without causing consumption in normal dentin [59].

A clinical study by Yazici showed that when laser technique applied for caries removing; a good acceptance of patients was happen. Clinical and radiological proceeding for patients after two years later approved protection on pulp vitality and excellent marginal sealing without any recurrent caries under restorations [60]. We can able to determine a point (end of preparation) thus by depending on dentin luminescence by laser ray, Where this is vary from a normal dentin luminescence. So this is useful in diagnosis of caries lesions [59, 61, 62, 63]. This is returned to the difference of chemical structure between caries & normal dentin, such as a high presence of bacteria and proteins in caries dentin [62, 63]. Delme KIM found that dental cavities which prepared with Er: YAG laser had clean and rough surfaces with opened orifices of the dental tubules without micro cracks [64].

Laser radiation caused water vaporization from intertubular dentin more than from circumtubular dentin, this leaded to dentinal protrusions formation which gave rough dental surface [63], and this is very suitable for increasing the stability of bonding restorations which may be used [64]. Using laser in dental cavities preparation and caries removing depended on what called (Separation Mechanism) where dental tissues removal under thermal and mechanical effects of applied laser radiation [65].

Materials and Methods

The research sample consist of 80 lower and upper molars, all molars were cleaned and to the remaining tissues were removed then molars were rinsed by water and brush. Extracted teeth were stored in plastic containers which contain on physiological serum which was weekly replaced for protection from infection until the time of preparation. Molars were fixed on resin matrix, where all the crown stayed externally from acryl and the root stick in the acrylic matrix. Then the tubercles were removed from all the molars in the research sample and enamel layer was also removed above the dentinoenamel junction at 1mm by using empty discs where dental surface in all molars became exposed. The sample was divided randomly as the following:

First Group: included 40 molars were also subdivided randomly into two branches groups (A&B) each of them included 20 molars.

Second Group: included 40 molars were also subdivided randomly into two branches groups (C&D) each of them included 20 molars also.

Molars of first group were prepared by using diamond burs (DI_Burs) at measure 21_SF, where were exchanged after preparing five molars.

- About 2mm from dental thickness was eliminated, we determined parts thickness by using H-file and the endodontics ruler.
- Each molar from the group were etched by phosphoric acid 37% (alpha each) for 15 seconds, then were rinsed by air & water stream for 10 seconds and later dried by gentle air stream until obviousness of the chalky appearance.

We applied a bonding material (single bond 2) on the molars of subdivided group A that is accord to Z 250 composite.

After applying on acrylic matrix which was especially manufactured for this research, it was defined as an matrix was applied before composite applying, the matrix length was 2cm and its width was 2cm, it had an empty cylinder in the middle of it, the cylinder diameter was 2mm.

The bonding material were applied on two layers and was cured by blue light for 20 seconds according to the instructions of the manufactured company.

- (Z-250) Composite was applied inside the matrix on two layers, until the restoration reached 2mm in depth, each

layer was cured by using [Bluedent LED Smart cord less] for 20 seconds according to the instructions of the manufactured company.
- All twenty molars in the group A were restorated in the same method.
- We applied a bonding material (Tetric N- Bond) on the group B that are accordant to Tetric N- ceram composite, then it was cured for 20 seconds according to the instructions of the manufactured company.
Preparation molars of second main group:
After all the necessity safety precautions were token; as wearing protective glasses, closing the doors that lead to research unit that to prohibit entering of any one to the working unit and examine working system and ensuring from its safety.
we prepared these molars by using of Er: YAG laser radiation and with the handpiece which number is 2060 according to the following arrangements: (the Er: YAG laser-KAVOIII, of high energy and wavelength of 2.94µm, was placed at 12 mm from the tooth surface for 30 seconds, with 250 mJ of energy pulse and 4 Hz of frequency yielding; according to the instructions of manufactured company), with a light current of (air and water) applied in a kindly circle movement without pressure.
- Molars of second group were etched by phosphoric acid 37% for 15 seconds also, and were rinsed by light airflow until obvious the chalky appearance.
- [Singel bond 2] was applied on group C molars which is suitability to the Z250 composite, as in group A from traditional preparing sample.
- Z250 composite restorations were applied on the dental surfaces as in sample A also.
- [Tetric N - Bond] was applied on group D molars which is suitability to the composite (Tetric N - Ceram) then each layer of the restorative material was cured for 20 seconds according to the information of manufactured company.
- (Tetric N - Ceram) composite restorations were applied on group C molars on two layers at 2mm thickness, are cured for 30 seconds according to the information of manufactured company.
- Each tested cylinder was fixed horizontally on the (Instron's hand) and vertical force was applied by using a metal knife with sharp head with a speed 0.5 mm/min. Thus on the separating surface between restoration and teeth. The power was recorded continuously until the restoration was broken up from teeth, after this we were recorded the digital value of the shearing force by (kg).
Then we were changed this value to (Newton) and calculated the shearing strength by (MegaPascal).
The changing of this value from (kg) to (Newton) was executed according to the following law (N9.81=1 Kg)
Calculating this strength (or the bonding force that resistant to shearing) by Megapascal according to the following relation:
SBS=F/SA
F (N) The applied force (Newton) = the power (kg) x9.81
SA (MM2) Shearing surface area =TTr2 = 3.14x (1)2= 3.14 mm2
SBS (MPa) shearing power (Megapascal)
We concluded values of the bonding strength as seen in the following table:

First Group by Traditional preparation group	Second Group by laser Er: YAG preparation group

Table 3: values of the bonding strengths (megapascal)

Group (A) shearing strength (MPa) for dental restoration by composite Z250	Group (B) shearing strength (MPa) for dental restoration by composite Tetric n- ceram	Group (C) shearing strength (MPa) for dental restoration by composite z250	Group (D) shearing strength (MPa) for dental restoration by composite Tetric n- ceram
9.91	11.38	16.52	6.9
14.43	15.27	14.63	19.3
11.24	12	14.54	10.72
17.2	14.57	18.2	12.42
15.13	19.1	7	15.49
12.32	13.53	12.85	15.53
14.43	11	10.74	17.2
13.5	15.27	11.9	11.55
15.43	16.22	17.43	13.73
10.46	15.43	18	16
6.2	9.53	13.73	15.3
13.27	12.42	15.42	12.61
16	10.55	17.31	16.2
12.42	17	9.7	17.12
18.78	15.12	11.86	13.67
10	12.18	13.61	15.6
12.56	10.49	9.83	14.1
15.21	5.8	15.67	19.9
11.35	16.1	20.1	12.61
16.31	11.18	14.84	14

Statistical - Analytical Study
We measured the amount of shearing force (megapascal) for each molar from the molars in the research sample, then we studied the effect of both using restoration materials and preparation method which was used in the amount of shearing strengths (mogapascal) and the analytical results were as the following:
First: Study the effect of preparation method which proceeding in the values of shearing forces (megapascal) in the sample of research according to the restoration material are used:
T-Student test was done for the independent samples to study the difference in the values of shearing strengths amount by (megapascal) between Er: YAG laser preparation group and diamond burs preparation group in the research sample according to the restoration material that used as following:

Table 4: shown the mean, the divert criterion, the wrong criterion, the lower limit & the upper limit to the amount of shearing forces (mega pascal) in samples of research according to the restoration material which is used & the preparation method which is followed.

Studied variable = amount of shearing strengths (megapascal)							
Restoration material which used	Preparation method which followed	Molars number	The mean	The divert criterion	The wrong criterion	The lower limit	The upper limit
Tetric-N-ceram restorations	Preparation by Er: YAG laser	20	14.50	2.99	0.67	6.9	19.9
	Preparation by diamond burs	20	13.21	3.11	0.70	5.8	19.1
Z250 restorations	Preparation by Er: YAG laser	20	14.19	3.34	0.75	7	20.1

	Preparation by diamond burs	20	13.31	2.96	0.66	6.2	18.78

The results of T- student test for the independent samples:

Table 5: shown the results of T- student test for independent samples for studying the difference refernce in the values of shearing forces (megapascal) between preparation groups by using Er: YAG laser & diamond burs in samples of research according to the restoration material which is used.

Studied variable = amount of shearing forces (megapascal)						
Restoration material which used	Calculated T- value	Free Degree	The difference between two means	The wrong criterion of the difference	Amount of refer level	The difference reference
Restorayion by composite tetric N ceram	1.339	38	1.29	0.96	0.189	No difference
Restoration by composite Z 250	0.888	38	0.89	1.00	0.380	No difference

The results above show the value of reference level is more than 0.05, whatever the type of restoration material which used; this means when it's in the confident level 95% there is no difference has statistical reference in the values of shearing strength (Megapascal) between both prepared groups (Er: YAG laser and diamond burs) in each molars group which restorated by (Tetric N- ceram) and molars group are restorated by composite Z 250 in the research sample.

- The study of the effect of the restoration materials which were used in the amount of shearing strength values in the research sample according to the followed preparing method:

We performed T- student test for the independent samples to study the meaning difference in the amount of shearing strength (megapascal) between the group molars which were restorated with (Tetric N- ceram) composite and the others which were restorated with Z- 250 composite of the research sample according to followed preparing method as the following:

- The results of T- student test for the independent samples:

Table 6: shown the results of T- student test for independent samples of study the difference in the values of shearing forces (megapascal) between molars group that are restorated by composite tetric N- ceram & Z 250 is samples of research according to the preparing method is proceeded

Studied variable = amount of shearing forces (Megapascal)						
Preparation method which is proceeded	Calculated T- value	Free Degree	The difference between two means	The wrong criterion of the difference	Amount of refer level	The difference reference
Preparation by laser Er: YAG	0.303	38	0.30	1.00	0.763	No difference
Preparation by Diamand burs	-0.105	38	-0.10	0.96	0.917	No difference

The results of T- student test for independent samples of study the difference in the values of shearing strength (Megapascal) between molars which were restorated by (Tetric N-ceram) composite and Z 250 composite in the research sample according to the preparing method which was proceeded.

The Statistical tables shows the amount of referent level it's more than 0.05, whatever type of the restoration material which was used, this mean it's in the confident level 95% there is no reference in statistical difference in the amount of shearing strength values (Megapascal) between the molars sample either wre restorated by (Tetric-N- ceram) composite or (Z250) composite in all groups that which prepared by Er: YAG laser or diamond burs.

Discussion

With the complications that are accompanied with the traditional preparation such as loss in sound dental tissues, damage to an adjacent tooth and the noisy sound which is accompanied with burs using; it was necessary to research in the laser radiation as a new method for cavities preparation and caries removal [67]. According to study of Kataumi M; preparation by Er: YAG laser didn't leave a stain layer and the electronic microscopic examination also appeared that preparation by Er: YAG laser gave a rough dentin surface and didn't cause micro explosions and evaporation in the dentin materials, this considered typically to improve the bonding forces with dentin [68]. According to Visuris's research which carried out in the restorations bonding strengths of composite with the prepared dentin by Er: YAG laser with or without acidic etching by phosphoric acid 37%, found that bonding strengths in cavities which were prepared by laser and etched by phosphoric acid 37% for 15 seconds was high noticeable from others which were prepared by laser without applying acidic etching [69], and this disagree with this research's results. The disagreement in the results may be back to that Visuris used laser Er: YAG laser radiation in variable criteria from which we applied in this study where Visuris used Er: YAG laser at wave length (2.94 nano meter), a frequency at 6 Hz and energy equally to 350 mJ [68].

The results of this study disagreed with the results of Kinney JH study, that because of Kinney found that preparation by Er: YAG laser which followed of acid etching by (phosphoric acid 37%) and applying of rinsing bonding material; gave the highest bonding strength, while the bonding strengths were weaken when the cavities were prepared by Er: YAG laser and self-etching bonding material was applied, that because of laser preparation formed an acid reluctant layer on the dental surface and that acid which in the self-etching bond wasn't enough to complete the layer conditioning [70].

Also this study disagreed with study of Yamamotoh, which showed that resin bonding strength with cavities which were prepared by Er: YAG laser were more weaken than composite bonding strength with cavities which were prepared by diamond burs; that because of formation of the acid reluctant layer after laser radiation was apllied and especially after applying a self-etching bonding system [71]. This disagreement perhaps back to disagreement of studious

criteria where Yamamotoh conserved sample's teeth in distilled water for a period of two months after they restorated teeth by composite, while the sample of this study does not exposed for the storing after restoration. This study results disagreed with the results of studies of Cooper F, Wright GZ and Delme kim, where the previous studies found that preparation of cavities by Er: YAG laser at wave length 2.94 nanometer and a frequency of 6 Hz and energy of 350mJ; without following it by an application of acid etching which leaded to noticeable improvement in bonding strength. These studies depended on absence of a stain layer for Justification that is no need to acid etching.

The disagreement perhaps because of this study acid etching acid by phosphoric acid 37% for a period 15 seconds was applied, while the previous studies didn't used an acid etching [72]. Results of this study agreed with the study of (Barcleiro Mo) and study of (Dalia MP), where those two studies showed that there was no difference between composite restorations bonding strengths on the posterior teeth that are prepared by diamond burs and that were prepared by Er: YAG laser, whatever the bonding system which was used [73, 74]. The previous studies disagreed with study of Van Meerbeek B where found that cavities preparation by Er: YAG laser without following it by acid etching leaded to decreasing in restorations bonding strength of with dentin in posterior teeth, that because of laser gave a rough dentin surface, but it didn't expose the unmineralized micro collagen fibers which consider essential in formation of hybird layer with adhesive materials. Therefore this layer didn't form after laser preparation that made the bonding strengths weaken [75].

As this study disagree with the study Van Meerbeek B, where this study didn't find differences in bonding strength of composite restorations with prepared dentin by Er: YAG laser which followed by application of an etching acid and composite bonding strengths with dentin surfaces which were prepared by diamond burs.

This study agreed with Susan AH study and Cal_weto Jp Study that proved that bonding strength of composite restorations with dental surfaces which were prepared by Er: YAG laser were similar to bonding strengths of composite restorations with dental surfaces which were prepared by diamond burs; whatever the bonding system was applied.

Despite that two previous studies referred to after some time the bonding strengths with (self-etching) bonding system will be lesser than bonding strengths with (dual -steps) system [76, 77]. This leaded with time to failure in the internal surface bonding with the bonding material because of water absorption of bonding agent from oral region and pulp [78, 79].

Conclusions

Through the current research which aim to evaluate the difference of bonding strengths of posterior composite restorations with the dentin after two different preparation methods (traditional preparation by diamond burs and preparation by Er: YAG laser), so we may be possible to conclude the following:

1. There is no difference in bonding strengths between the group which prepared by diamond burs and the other which prepared by Er: YAG laser.
2. The difference of restoration material type and bonding material didn't effect on restorations bonding strengths in both groups.
3. That any of the methods of mentioned preparation are progress acceptable clinical bonding.

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