Original Article

Effect of Laser Etching and Spark Erosion on Retention and Resistance of Partial Veneer Crown Copings Luted with Adhesive Resin Cement

Abstract

Purpose: There has been less focus on methods to improve the clinical performance of partial veneer crowns. In this study, we wanted to explore the potential of two new surface treatment modalities (laser etching and spark erosion) for improving the longevity of partial veneer crowns. **Material and Methods:** Conventional partial veneer crown preparation was done on 90 extracted premolars by a single operator. All the samples used in the study were divided into three groups. Group A were samples to be treated by sandblasting alone, Group B were samples to be treated by sandblasting followed by laser etching, and Group C were samples to be treated by sandblasting followed by spark erosion. Each group consisted of two Sub Groups: Sub Group I-Retention test group, Sub Group: II-Resistance test group. The prepared teeth were randomly allotted to the three groups and subgroups using lot method. Partial veneer crown copings were fabricated for testing retention and resistance. Castings in each subgroup were luted with resin cement to their respective tooth preparations. Retention and resistance testing of samples were done with the use of an Instron Universal testing machine. **Results:** The two surface treatments, laser etching and spark erosion (Groups B and C) of metal copings significantly improved the retention and resistance compared to sandblasted surfaces alone ($P \leq 0.05$). Retention and resistance of copings which were sandblasted and spark eroded (Group C) were found to be highest among the three groups ($P \leq 0.05$). **Conclusion:** Within the limitation of this study, it can be concluded that the combination of spark erosion and sandblasting significantly improves the retention and resistance values of partial veneer crown. This study helps to provide better knowledge about the surface treatment required for success of partial veneer crowns.

Keywords: *Laser etching, partial veneer crown, resistance, retention, sandblasting, spark erosion, surface treatment*

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Introduction

Prosthodontic treatment of crown and bridge comprises of tooth preparation followed by cementation of complete or partial veneer crown retainers to the prepared tooth surface. Current practices in the preparation of tooth are misusing irreplaceable enamel. Sturdy and skillful methods of tooth preparation have fallen by the wayside and have been replaced by a phenomenon called full coverage. Full-coverage restorations in a patient who have less caries susceptibility can be more destructive than beneficial.[1-3] Full-coverage restoration is easier to prepare than that of partial coverage; however, it is always done at the expense of tooth structure. Partial veneer crowns have numerous advantages over full crowns. Apart from limited tooth preparation and conservation of tooth structure, a partial veneer crown offers more accessibility to the preparation margins and better esthetics than a full crown.[4] With this, it is easier for the patient to maintain hygiene and the dentist can record the margins better during impression procedures. Less contact of restoration near the gingival margin is favorable for healthy gingiva. The dentist can evaluate the seating of the margins better in a partial veneer crown and can even perform an electric pulp test if required. Partial veneer crown preparation involves only few surfaces of the clinical crown, and thus the total surface area available for retention of the prosthesis is decreased compared to full veneer crowns.[5,6]

Full crowns, on the other hand, do not guarantee of being a superior restoration or with fewer complications. It has been

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estimated that the 10 years risk for biological failures in conventional full-coverage-fixed partial dentures (FPD) such as caries and loss of abutment vitality is close to 9.5% and 10%, respectively, and nearly 2.6% of FPD's were lost due to caries. Failure of full-coverage FPD due to mechanical complication (loss of retention) is estimated to be 6.4% over a period of 10 years.[7-9] Long-term studies on clinical success of partial veneer crowns are limited in literature. A study on clinical performance of conventional partial veneer crowns showed that the failure rate was close to 20%, mainly attributed to loss of retention and to a very lesser extent caries. No loss of vitality was reported.[10] This is very close to the survival rates of resin bonded retainers as reported in various studies.[11-14] Failure rates of partial veneer crowns are more than full crowns and are mostly due to debonding of the prosthesis. Partial veneer crowns are still clinically unpredictable, and hence, a there is a shift towards more predictable full crowns. Thus, a satisfactory restoration which employs principles of sound engineering and down-to-earth conservation can avoid the indiscriminate use of full coverage.

Partial veneer crowns cover more surface area than resin bonded bridges and lesser surface area than full veneer crowns and have the potential to exploit the advantages of both conservation and clinical longevity. There has been less focus on methods to improve the clinical performance of partial veneer crowns although there have been numerous efforts to improve retention of resin bonded retainers. The previous studies on resin bonded retainers have employed different methods to improve retention such as using perforated retainers[15] or creating micromechanical features for retention using electrochemical etching[16,17] or particle roughening.[18] It has been shown that micromechanical retentive features are more efficient than macro-mechanical retention.[19-21] Various other surface treatment methods have been tried to improve the retention and resistance of the fixed prosthesis. The most common method employed is sandblasting with alumina particles.[20] An alternative to conventional surface treatment methods is laser etching. Surface treatment with laser is considered to be advantageous because of its depth of optical penetration when combined with sandblasting.[22] Another modern way of altering the surface of metal alloy is the spark erosion. The alloy surface is eroded with rapidly recurring current discharge by electrodes. In this process, the metal is eroded in a controlled manner in the presence of an alcoholic solution.[23] This modern method has been applied widely in implant dentistry to improve the precision of fit and retention of prosthesis.[24,25]

In this study, we wanted to explore the potential of these two new surface treatment modalities (laser etching and spark erosion) for improving the longevity of partial veneer crowns. The aim of our study was to evaluate the effect of the three surface treatments (namely, sandblasting, laser etching, and spark erosion) on the retention and resistance of partial veneer crowns. The null hypothesis stated that there is no difference between the three surface treatments. Currently, there is limited evidence in literature to provide any conclusive evidence on the effect of these surface treatments on longevity of partial veneer crowns. Thus, clinically, the findings from this study could help to improve the longevity of partial veneer crowns along with the added advantage of conservation of tooth structure.

Materials and Methods

Ethical clearance was obtained from the Institutional Review Board (Approval No: SRMDC/IRB/2014/MDS/No. 206). Total of 90 extracted intact human maxillary first premolars, extracted for orthodontic treatment, were used in this study. Roots of the specimen were notched and embedded in auto-cured acrylic resin (DPI RR– Cold cure, Dental Products of India, Mumbai, India) blocks of size 15 mm × 15 mm × 25 mm [Figure 1]. Auto-cured resin was mixed in a ratio of 3:1 by volume, and the teeth were embedded such that the cementoenamel junction was above the resin by 1–2 mm. Conventional partial veneer crown preparation was done on all the embedded teeth using high speed handpiece and water coolant [Figure 2]. Putty index (Aquasil Soft Putty/Regular Set, Dentsply Detrey GmbH, Konstanz, Germany) of each tooth was made before tooth preparation. All the preparations were done by a single operator. Standard round end-tapered diamond bur (TR-13, Mani Inc., Utsunomiya, Tochigi, Japan) was used for occlusal reduction and functional cusp bevel. The clearance was 1.5 mm on the palatal cusp and 1.0 mm on facial cusp. Lingual preparation was done using a standard torpedo diamond bur (SO-21, Mani Inc., Utsunomiya, Tochigi, Japan). Proximal reduction was done using a standard needle-shaped diamond bur (TC-11, Mani Inc., Utsunomiya, Tochigi, Japan) and completed using standard torpedo diamond bur. Axial and proximal reductions were done to a depth of 1 mm resulting in a chamfer finish line 1 mm above the cementoenamel junction. The facial surface

Figure 1: Test samples embedded in auto-cured acrylic resin

was left intact. Proximal retention grooves were placed using 169 L carbide bur (169-L, Mani Inc., Utsunomiya, Tochigi, Japan) to the depth of the bur. Occlusal offset was made to a depth of 1 mm using the same 169 L bur. Proximal flares and bevels were made using standard flame-shaped diamond bur (FO-11, Mani Inc., Utsunomiya, Tochigi, Japan). Preparations were finished using extra fine round end-tapered diamond (TR-25EF, Mani Inc., Utsunomiya, Tochigi, Japan). After preparation, the teeth were rinsed and cleaned with distilled water in an ultrasonic bath.

All the samples used in the study were divided into three groups based on the type of surface treatment. Group A was samples to be treated by sandblasting alone, Group B was samples to be treated by sandblasting followed by laser etching, and Group C was samples to be treated by sandblasting followed by spark erosion. Each group consisted of two subgroups: Sub Group I -Retention test group, Sub Group II -Resistance test group. The prepared teeth were randomly allotted to the three groups using lot method in a ratio of 1:1:1 resulting in 30 samples per group. The lots were picked up by an individual who was not involved in the study. A similar lot method was followed to allot the teeth to either of the subgroups: Retention test group (Sub Group I) or resistance test group (Sub Group II) in an allocation ratio of 1:1 resulting in 15 samples in each subgroup**.**

Individual dies were formed with type IV die stone (Elite Rock, Zhermack spa, Italy) for each prepared tooth for fabrication of direct wax patterns. Wax patterns (Crown wax hard, BEGO GmbH and Co. KG, Bremen, Germany) were immediately sprued, invested and cast using base metal alloy (Wiron 99, BEGO GmbH and Co. KG, Bremen, Germany). Castings in the retention test group were fabricated by attaching a 2.5 mm sprue wax (Wax sprue wire 2.5 mm, BEGO GmbH and Co. KG, Bremen, Germany) to the marginal ridges to produce a U-shaped loop to test retention [Figure 3]. The U-shaped loop provided the attachment for a hook for testing retention. Castings in the resistance test group were designed so that the crowns would have a fossa approximately 4 mm in diameter and 2 mm deep in the center of the crown to test resistance [Figure 4]. The fossa provided space to accommodate a steel ball to which the force for resistance is applied. Castings were recovered from the investments cleaned, finished with 400 and 800 grit finishing stones and were fit to the respective teeth.

The fitting surfaces of all the samples were sandblasted with 100 μ aluminium oxide at a distance of 10 mm for 10 s at an air pressure of 70 psi followed by rinsing in ultrasonic bath for 15 s to remove excess aluminum oxide. Samples in Group A were subjected to sandblasting alone. Group B samples were sandblasted and subjected to laser etching using Nd:YAG laser (YAG Laser marking machine, SYD-60, Dongguan Kite Laser Technology Co., Ltd. Guangdong, China). The fitting surface of the copings was irradiated with a glass fiber of Nd:YAG laser with a power of 2kW, energy of 120 mJ and a frequency of 50 Hz for 5 s.[26] The set of samples in Group C were sandblasted

Figure 2: Conventional partial veneer crown preparation

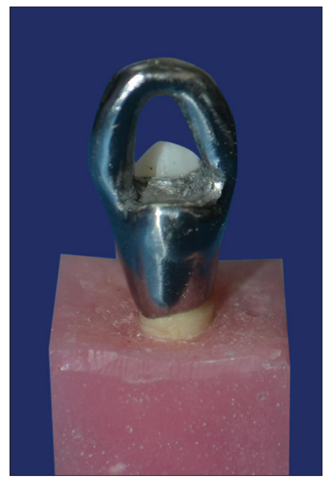

Figure 3: Retention test sample

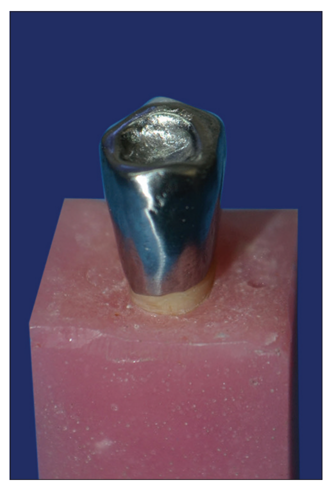

Figure 4: Resistance test sample

and subjected to spark erosion using electrical discharge machining (EDM) device (CNC EDM Machine, Model: CNC341s, Creator Industry– Suzhou Co., Ltd. Jiangsu, China). The castings were held in a holder in the machine and stabilized. A thin copper electrode was used as the spark erosion tip. Spark erosion was carried out with a potential of 90 kV and current of 0.5–1.5 A.[27] A dielectric liquid was used as a coolant [Figure 5a and b]. The electrode was moved manually using a control unit over all the fitting surface of the castings. After surface treatments, all castings were cleaned in an ultrasonic bath.

The fit of the castings was verified on the tooth preparations using a stereomicroscope and only those castings which demonstrated marginal discrepancy within 0.1 mm (100 μm) were used for the study. The clinically acceptable marginal discrepancy of crowns ranges from 50 to 120 μm.[28] Castings in each subgroup were luted with resin cement (Panavia F 2.0, Kuraray America, Inc., NY, USA) to their respective tooth preparations according to manufacturer's recommendations. Briefly, alloy primer liquid (Alloy Primer, Kuraray Noritake Dental Inc., Okayama, Japan) was applied on the fitting surface of the castings and dried for 30 s. The primer liquids (ED Primer II Liquid A and Liquid B, Kuraray Noritake Dental Inc., Okayama, Japan) were mixed and applied on the tooth surface for 30 s using small brushes and then air dried. An equal amount of Panavia paste A and B (Panavia F 2.0; Paste A and Paste B, Kuraray Noritake Dental Inc., Okayama, Japan) were mixed and applied on the inner surface of the castings and cemented on to the prepared teeth. The margins of the cemented castings were light cured (Blue Phase, Ivoclar Vivadent AG, Schaan, Principality of Liechtenstein) for 20 s and the excess cement was removed. Oxygen protecting gel (Oxyguard II, Kuraray Noritake Dental Inc., Okayama, Japan) was applied over the margins for complete curing of the resin cement. After the cement was set, all the test specimens were stored in a water bath at a 37°C for 24 h.

Retention and resistance testing of samples were done with the use of an Instron Universal testing machine (3382 Floor Model Universal Testing System, Instron industrial products, PA, USA). For testing of retention (Sub Group I of Groups A, B, C) a self-aligning apparatus attached to the crosshead of the Instron machine was connected to the U-loop of the crown, such that the long axis of the preparation was coincident with the path of removal [Figure 6]. The crowns were separated from the blocks at a cross-head rate of 0.5 mm/min and the tensile forces required for crown removal were recorded as retention value**.** Resistance to dislodgment (Sub Group II of Groups A, B, and C) was tested by applying a force in a direction oblique to the path of insertion [Figure 7]. The block with cemented casting was bolted onto a 45° ramp in a machined stabilizing block which was positioned and secured to the load cell of the Instron machine. A ball

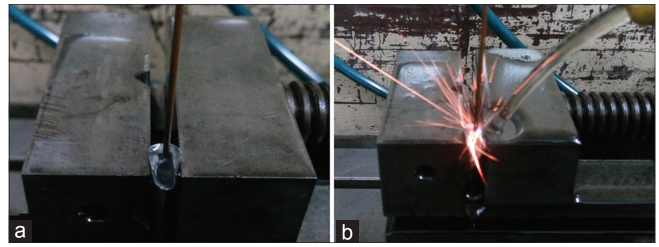

Figure 5: (a) Copper electrode for spark erosion, (b) Spark erosion using a copper electrode and dielectric fluid

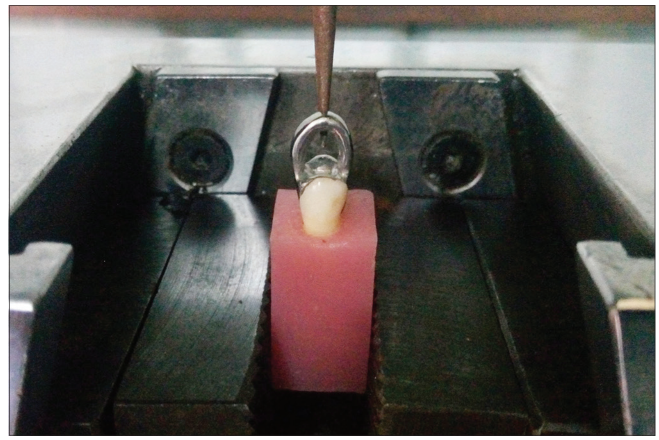

Figure 6: Testing of retention

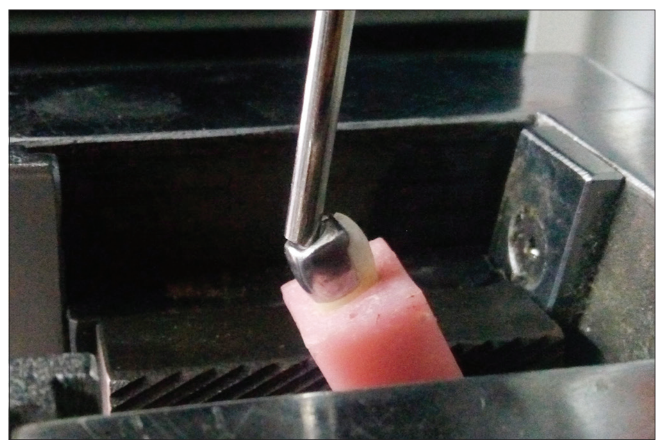

Figure 7: Testing of resistance

bearing 5/32 inch (4 mm) in diameter was placed in the fossa on the lingual cusp of the crown. A tapered steel stylus attached to the cross-sectional head of the machine was lowered into the position until a concave depression in its tip was firmly seated over the ball bearing. Shear force was applied at a cross-head rate of 0.5 mm/min until the crown was dislodged. The force was measured and recorded as resistance value.

Results

Table 1 and Figures 8, 9 shows the retention and resistance values (in Newtons) obtained for Groups A, B, and C, respectively. Values are as expressed as mean ± standard

Table 1: Descriptive statistics for retention and resistance tests

Test	Groups	Sample size (*n*)	Maximum (Newtons)	Minimum (Newtons)	Mean±SD
Retention testing	Group A	15	280	160	210.53±19.35
	Group B	15	170	250	244.0±29.87
	Group C	15	268	272	270.0±1.60
Resistance testing	Group A	15	550	630	592.73±19.82
	Group B	15	591	659	619.20±20.24
	Group C	15	629	720	663.80±27.33

Retention and resistance test values are presented as mean±SD. Group A: Sandblasting; Group B: Sandblasting and laser etching; Group C: Sandblasting and spark erosion. SD: Standard deviation

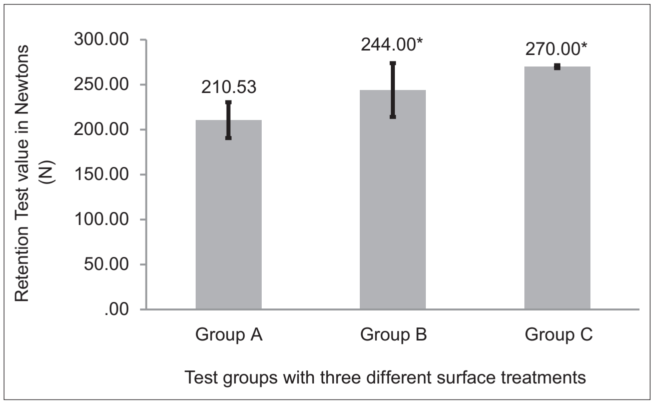

Figure 8: The graph presents mean values (in Newtons) obtained from retention testing after three different surface treatments. Group A – Sandblasting, Group B – Sandblasting and Laser etching, Group C – Sandblasting and Spark Erosion. Error bars indicate standard deviation. *Significant differences compared to Group A ($P \leq 0.05$). Results of retention testing of samples after three different surface treatments

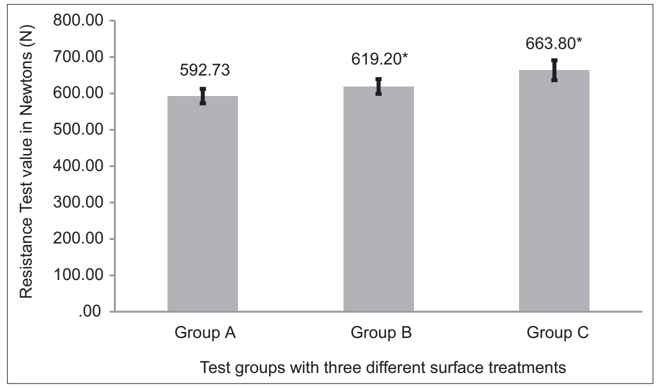

Figure 9: The graph presents mean values (in Newtons) obtained from resistance testing after three different surface treatments. Group A – Sandblasting, Group B – Sandblasting and Laser etching, Group C – Sandblasting and Spark Erosion. Error bars indicate standard deviation. *Significant differences compared to Group A ($P \leq 0.05$). Results of resistance testing of samples after three different surface treatments

deviation. The data were checked for normality using Kolmogorov–Smirnov test and were found to be normally distributed. Hence, the data were statistically analyzed using one-way ANOVA [Table 2] followed by Tukey's Honest Significant Difference as a *post hoc* test [Table 3] using IBM SPSS Statistics for Windows (Version 19.0, IBM Corp., Armonk, NY, USA). Mean retention test values of Groups A, B, and C was 210.533 ± 19.35 N, 244.00 ± 29.871 N, and 270.00 ± 1.604 N, respectively. Mean resistance test values of Group A, B, and C were 592.73 ± 19.82 N, 619.20 ± 20.24 N, and 663.80 ± 27.33 N, respectively. The two surface treatments, laser etching and spark erosion (Groups B and C) of metal copings significantly improved the retention and resistance compared to sandblasted surfaces alone ($P \leq 0.05$). Retention and resistance of copings which were sandblasted and spark eroded (Group C) were found to be highest among the three groups ($P \leq 0.05$).

Discussion

This study evaluated the retention and resistance of partial veneer crowns with different surface treatments (sandblasting, laser etching, and spark erosion). It has been established beyond doubt that retention and resistance are indispensable for success of extracoronal restorations such as complete and partial veneer crowns. Retention of crowns depends on the length, height, taper, surface area, and surface roughness of the preparations. In contrast to retention, features of resistance are those that prevent the dislodgement of the prosthesis when the prosthesis is subjected to nonaxial forces.[28,29] In our study, conventional preparation geometry to achieve retention and resistance for partial veneer crowns was incorporated, and all the samples were prepared by a single operator to minimize variations in preparation and human error. To minimize bias due to variation in height, length and surface area of the preparation, we allotted all the samples to the three groups randomly using a lot method as mentioned before. The luting cement was the same between all the samples. Thus, the variations seen in the results of retention and resistance testing from our study could be attributed purely to the effects of surface treatments and the resulting strength of metal-resin bonding.

Retention and resistance of partial crowns could be improved either by changing the preparation geometry or by improving bonding of the restorations. In our study, we have focussed on methods to improve metal-resin bonding and adopted conventional geometric preparation for partial veneer crowns. With improvements in resin systems, bond strengths of metal-resin-tooth have increased significantly leading to more predictable clinical outcomes.[30,31] It has also been shown that micromechanical retentive features improve resin-metal bonding better than macromechanical features.[17] In our study, we found that sandblasting followed by spark erosion or laser etching significantly improved the retention and resistance of partial veneer copings compared to sandblasted surfaces alone. Thus, our null hypothesis is rejected and the alternative hypothesis is chosen. We also found that among all the three surface treatments, sandblasted and spark eroded samples (Group C) had the maximum retention and resistance.

Group A (Sandblasting) samples showed lesser values for retention and resistance when compared to Group B (Laser) and Group C (Spark erosion). This could be because the surface irregularities created by sandblasting were lesser compared to spark erosion or laser etching. Another major complication of sandblasting is retention of alumina particles on the alloy surface. The presence of such embedded fragments adversely affects the retention and resistance of metal-resin systems, decreasing the mechanical interlocking.[32] The micromorphological features of sandblasted surfaces are shown as shallow pits. Su *et al*. reviewed that increasing the sandblasting time and particle size (50 µ to 110 µ) has a positive influence on retention and resistance value.[33] As a result of sandblasting, surface energy is lowered which promotes adhesion. Mukai *et al*. concluded that sandblasting with different particles sizes acts as an adjunct to resin cement to improve the shear bond strength for resin with alloy.[34] Fonseca *et al*. showed variation in the grit size and applied pressure of alumina particles used in sandblasting can affect the irregularities caused on the alloy surface.[35] Thus, the surface roughness and resulting metal-resin bond strength is dependent on the particle size, particle shape, particle speed, density of particles, duration of blasting, air pressure and distance between the source of the particles and the surface.

Table 2: Comparison of retention and resistance across the groups

Test	Groups	Mean±SD	*F*	Significance (*P*)
Retention testing	Group A	210.53±19.35	30.947	0.000
	Group B	244.0±29.87		
	Group C	270.0±1.60		
Resistance testing	Group A	592.73±19.82	37.473	0.000
	Group B	619.20±20.24		
	Group C	663.80±27.33		

F and *P* value obtained from one-way ANOVA; $P \leq 0.05$ is considered significant. Group A: Sandblasting: Group B: Sandblasting and laser etching; Group C: Sandblasting and spark erosion; SD: Standard deviation; ANOVA: Analysis of variance

The increase in retention and resistance for Group B samples may be due to the ability of high energy laser to produce surface undercuts and micro defects on the intaglio surface of the partial veneer which enhances micromechanical retention of resin. This feature of laser etched surface as opposed to a simple roughened surface produced by sandblasting is more favourable for metal resin bonding. Combination of laser etching with sandblasting increased the debond strengths. This emphasizes that there is a direct correlation between microroughness and retention-resistance. da Silveria *et al*. concluded that the laser irradiated ceramic surface was more effective due to the low surface energy and rough surface created by the laser beam. When a ceramic surface treated with Nd:YAG laser was observed under scanning electron microscope (SEM) (×200 magnification), the surface pattern showed areas which appeared molten with presence of pores and craters, droplets and grits, thereby increasing the surface undercuts which enhanced adhesion. On the other hand, the surface morphology with sandblasted area caused a rougher surface with irregularities without any discernable defect on the surface.[36] Gorler and Ozdemir made a similar observation in nickel-chromium alloy surfaces treated with Nd:YAG laser. They concluded that during the laser energy discharge, surface changes were observed due to punctual action of laser micro explosion resulting in the formation of craters and pores. The deposition of spherical droplets is possibly due to the cast material nuggets close to the laser application point.[37] All these features of a laser etched surface contribute to increase is retention due to micro mechanical undercuts.

Surface irregularities can be more effectively created with help of the electrodes used in the spark erosion procedures. This process is based on thermoelectric energy between the work piece and an electrode. Here, the metal is removed by melting and vaporization in single sparks. When the voltage between the electrodes increases the erosion of the metal piece also fastens.[23] Spark erosion or EDM has been commonly used in dentistry to improve the fit of implant

Table 3: Tukey's *post hoc* analysis for retention and resistance tests

Test	Group	Group	Mean difference	*P*	Upper CI	Lower CI
Retention testing	Group A	Group B	−33.467*	0.000	−51.88	−15.05
		Group C	−59.467*	0.000	−77.88	−41.05
	Group B	Group C	−26.000*	0.004	−44.41	−7.59
Resistance testing	Group A	Group B	−26.467*	0.007	−46.63	−6.31
		Group C	−71.067*	0.000	−91.23	−50.91
	Group B	Group C	−44.600*	0.000	−64.76	−24.44

P values are obtained from Tukey's *post hoc* analysis; $^*P \leq 0.05$ is considered significant. CI: Confidence interval at 95%; Group A: Sandblasting; Group B: Sandblasting and laser etching; Group C: Sandblasting and spark erosion prosthesis.[24,25] This type of EDM uses a prefabricated electrode with a specific shape that is used to machine the workpiece accurately to specific dimensions. This process ensures precise fit. In our study, we have used a copper electrode instead of a prefabricated electrode as the configurations of the preparations vary with the size and shape of the natural tooth and hence a uniform electrode cannot be used for all the samples. This type of spark erosion uses a thin wire electrode which permits it to be used for complex shapes. Use of a wire electrode negates the need for fabrication of complex electrodes.[38]

Group C samples treated with spark erosion had high values of retention and resistance ($P < 0.001$) compared to the other two groups. Observed results can be explained by the ability spark erosion process to improve the fit of a prosthesis and to induce surface changes/elemental alterations on the metal surfaces. Process of spark erosion is well known to produce dental restorations with improved fit. With the improvement in the fit of prosthesis, there is also an in increase in the retention and resistance of the prosthesis.[23] Surface changes and elemental alterations caused by spark erosion process were studied by Zinelis.[27] Metal surfaces treated by spark erosion were found to have a layer called as the "Recast Layer" which was formed due to melting, evaporation, and resolidification of the molecules on the surface of the metal. SEM analysis of the metal surfaces showed rough texture with amorphous interconnected islands (craters) and large number spherical pores. The large pores on the surface are created by the explosion and subsequent evaporation of the dielectric fluid during spark erosion.[27] All these features improved the surface area and thus metal resin bonding. Janda *et al*. concluded that spark erosion is an effective method to improve metal resin bonding thus enhancing retention and resistance.[39] Metal surfaces treated by spark erosion were also found to have an increased concentration of carbon and copper due to the decomposition of the dielectric fluid and the copper electrode, respectively. This also increased the surface hardness of the metals.[40,41] Whether the incorporation of carbon/copper and subsequent hardening of the metal surface really plays a role improving metal-resin bonding is unclear and yet to be investigated.

We did not calculate the surface area of each tooth preparation. We consider this as the limitation of our study. Any tool that helps in calculating the prepared tooth surface area would have made standardization better thus giving a more cleared picture of the effect of surface are to the strength of metal resin bonding. The potential of partial veneer crown is underestimated in clinical dentistry leading to numerous failures primarily due to lack of experience in tooth preparation and subsequent loss of retention. Combined with this, limited research focused on methods to improve clinical performance of partial crowns has led to a drastic decrease in its clinical use. More research and better training in clinical skills are the need of the hour which can exploit the benefits of conservation of tooth structure and clinical longevity offered by partial veneer crowns.

Conclusion

This study was conducted with the objective of analyzing the retention and resistance of partial veneer crown with different surface treatment methods such as sandblasting, laser etching, and spark erosion. Within the limitation of this *in vitro* study, from the data received, it can be concluded that combination of spark erosion and sandblasting significantly improves the retention and resistance values of partial veneer crown. This study helps to provide a better knowledge about the surface treatment required for success of partial veneer crowns. It can be useful in restorations with less surface area and can act as better adjunct to provide a long-lasting restoration.

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Conflicts of interest

There are no conflicts of interest.

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