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Comparison of surface roughness between CO_2 laser and typical glazing on two types of porcelain vita and ivoclar

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ABSTRACT

Existence defects in porcelain is directly related to the techniques of porcelain and firing cycles. Adjust glazed surface during clinical work to correct occlusal interferences surface and proximal are common, Which Leads to increased surface roughness. So do Glaze and polishing after Adjust process is essential. In this in vitro study evaluated two types of commercial porcelain with different crystalline content, VITA (Zahnfabrik, Bad Säckingen, Germany) and porcelain IPS d.Sign (Ivoclar Vivadent, Amherst, NY) each of the samples of porcelain were divided into 4 groups according to the two types of porcelain used, generally divided into 8 groups were divided. The laser co2 laser (ultra-dream pluse, Guro-Gu, Seoul, Korea) wavelength 10.6 (mμ) and with the 30W and the time of exposure 1 and 1/5 minutes was used. Standard polished group with sandy paper with a grit similar, According to the America Academy aesthetic dentistry was prepare. Surface roughness were evaluated using a profilometer and the two-way ANOVA test and post hoc Tukey test was used for statistical analysis of the samples. The findings of this study indicated that porcelain surface roughness by CO_2 laser glazed significantly less than typical Glaze, however, ANOVA test between average 5 groups length consecutive depth, did not show significant differences, Also, the surface roughness of CO_2 laser glazed porcelain were significantly lower than the polished porcelain. The surface roughness of glazed porcelain by laser CO_2 was less than of typical glaze.

INTRODUCTION

Dental porcelains have a significant role in dentistry due to properties such as color stability and chemical stability and low thermal conductivity and high bio compatibility but limited fracture strength of these materials limits their application. Presence of available defects in porcelain has a major effect on reducing life span of porcelain. Presence of available defects has direct relationship with process technique and porcelain firing

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cycles. Surface roughness increases followed by porcelain adjustment of surface pore, which acts as an important center of stress focus and often leads to catastrophic failure, (Morena 1986 Scherrer 1999, Griggs 1996, Kelly 1997, Raigrodski 2001 Raigrodski 2004, Gonzaga 2009, Garcia 2015, Alavi 2017 and Lohbauer 2017).

Glazing includes porcelain firingcycle near the sintering temperature (Chang 2011) and (Quinn 2012) porcelain surface melts during this cycle and Glassy Phase fillsSurface irregularities, the glazing is done as auto glaze and over glaze that both of whichglazingtechniques createsmoother surface with higher glass level and lower flows (Eppler 1983) and (Marshall 1993). Papers show that glazing has important role in reducing plaque accumulation in the porcelain surface (Brackett 1989) and (Motro 2012) and (Yilmaz 2010).

Using microwave techniques has been proposed as an alternative to typical glazing recently (Barghi 1976). Microwave leads to less surface defect and a smoother surface and requires lesstime. Using Co_2 laser leads to reducing surface roughness in comparison with typical laser but just in laser with high power co_2, better color has shown than typical glazing (Podshadley 1966). Porcelain surface density is created by different techniques in a wide range of ceramic materials which can be done by Thermal, mechanical and polished firing and putting a layer of porcelain with coefficient thermal expansion less than porcelain. CO_2 laser is very convenient for improving the level of dental porcelain because the emitted wavelength by this laser is absorbed entirely by porcelain (Fairhurst 1992). It was suggested that surface treatment of porcelain by laser prevents formation of micro cracks and leads to increased mechanical strength of porcelain. The present study reviews CO_2 laser as a surface treatment for porcelain glaze and compares results with typical glazing.

MATERIALS AND METHODS

In this study which is empirical_Laboratory type, 2 types of commercial porcelain with different crystalline content of VITA VM13 (Zahnfabrik, BadSäckingen, Germany) and porcelain IPS d.Sign (Ivoclar Vivadent, Amherst, NY) were selected (Barghi 1976) and (Brentel 2011), a brass generator was used to standardize the samples with 5 × 5 × 10 mm. Porcelain was placed in generator after mixing the powder and liquid. Extra humidity was taken by a handkerchief (Kleenex; Kimberly-clark, Neenah, wis) and all samples were placed on wetness (honey comb mesh tray; American dental supply; Allentown pa) andwere sintered in porcelain furnace (program at p 200; ivoclar vivadent) according to manufacturer's instructions as described below;

First, the samples were dried for three minutes, after3 minutes ofstanding onpreheat stage with speed of 83 ° C per minute were reached to temperature of 913 degrees Celsius and were kept at this temperature for 30 seconds.For sample preparation, two firing cycles were performedfor wind porcelain and enamel and one cycle was performed for glazing. Typical cyclewas roughed by a diamond bur

FIGURE 1

FIGURE 2

(2134F, KG Sorensen) with high speed along with water of samples surface (similar to clinical conditions of occlusal adjustment) and were divided into 4 groups that were divided into 8 groups generallybased on porcelain trade type. In this study, co2 laser (ultra-dream pluse, Guro-Gu, Seoul, Korea) was used with a wavelength 10.6 (mμ) and with power 30 W and exposure time 1 and 1/5 minutes. Co2 laser radiation is continuously and focuses directly on a samples that are placed on refractory base. Spot size of co2 laser was 5/0 cm.

Remaining sample of each type of porcelain was glazed in the usual way of furnace glazing and according to glazing manufacturer's instructions, also standard polished group was prepared with sandpaper bysame grits according to recommendation of American Academy of Cosmetic Dentistry (P360, P400 and P1200) (Fairhurst 1992).To investigate surface roughness, a profilometer (Mitutoyo Surf Test 402 Analyser; Mitutoyo crop, Kawasaki, Japan) was used with a pen diameter 12.5 mμ, pen power 10mg (Prasad 2009) and movement speed of co2 laser on the surface was 10 mm /min (Sgura 2015) and manually, and the entire sample length was scanned by profilometer (Mitutoyo Surf Test 402 Analyser; Mitutoyo crop, Kawasaki, Japan).

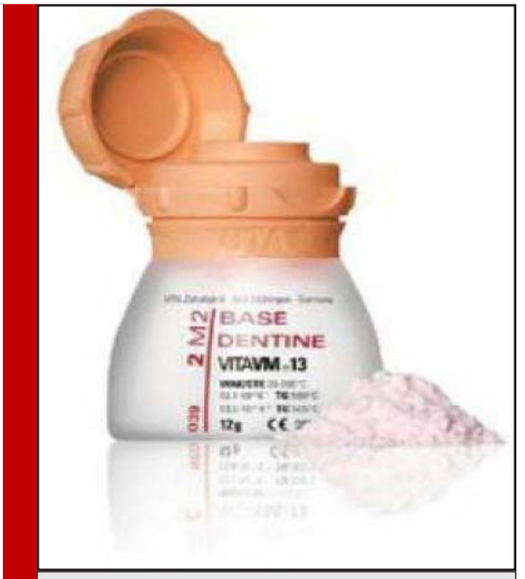

FIGURE 3

To measure surface roughness of samples by profilometerdevice, porcelains sample was placed in such a way that device indenter placed in middle part of sample in terms of width, then three times measurement were performed for each sample in this way, that average of three measured values for each sample was considered as an average of surface roughness for that sample. Parameters of the surface roughness were calculated by Ra (average of surface roughness heights that is obtained from dividing total area of roughness on sample length) and Rz (a fifth of sum of 5 consecutive peaks of surface roughness or in other words the average of the tallest roughness peaks (heights) in 5 sequence length of the sample that is measured according to micrometer) and Rpm /rz (Rpm is the average of depth length of 5 samples subsequent length). Two-way ANOVA test and post hoc Tukey test was used for statistical analysis of the samples.

DISCUSSION

According to performed statistical tests in this study and obtained data from these tests, VITA porcelains group

FIGURE 4

which had been typically glazed,had no significant difference with any group, but IVOCLAR porcelains group that was typically glazed had more surface roughness compared to VITA porcelains group which had been glazed with laser for 1.5 minutes. Although Vita porcelains that had been typically glazed, had no significant difference with any group, detection probability of this difference was existed in case of using more accurate methods such as SEM.

In particular, use of SEM could provide worthy help in detecting a difference of surface roughness in typical glazing groups with groups that were glazed withCO2 laser. Also, porcelains Microstructure structure can be a reason for mechanical and apparent difference of porcelain, that this matter can be a justification for providing different results, for example, in study of Sarac et al. (2005) difference in samples harness had been expressed as an evidence for providing different results in similar methods of polishing, Also, inmentioned study has been stated that the difference in surface roughness of the samples can be due to differences in samples characteristics (Sarac 2006); therefore, it is advised to evaluate structure of porcelains Microstructure with using X-ray in future studies.

There is significant difference between VITA porcelains group that have been glazed with co2 laser for 1 minute with VITA porcelains group that have been glazed with co2 laser for 1.5 minutes, whichis demonstrator of effect of time of using CO_2 laser for glazing. Regarding the IVOCLAR porcelains, in case of using accurate methods to survey the surface roughness, it was possible that time of using co2 laser had significant difference in surface roughness of samples in mentioned porcelain. Therefore, using more accurate methods of handling surface roughness such as use of SEM is suggested for further study.

Reham & coworkers in 2014 surveyed the roughness and surface properties of porcelain after typical glazing, glazing with xeclexcimer and CO_2 laser. They observedmore smoother and a more uniform surface than typical glazing in the survey with electron microscope in high power of both laser (Reham et al., 2014), which is seconder of present study findings.

ANOVA test also showed that there is significant difference between Rz of used porcelain groups in study that had been glazed typical with groups that had been glazed with co_2 laser (Rzof groups that have been glazed with co_2 laser is lower than groups that have been typically glazed) but significant difference was not observed between Ra and Rpm of groups. Ricardo and co workers considered CO_2 laser with three different powers as an alternative to oven glaze on 2 types of porcelain in 2013. Results of this study showed that the amount of surface roughness had no significant difference among various brands ofporcelain. They observed reduction of surface roughness in laser group with power 45w/cm2 compared to the control group but significant difference was not observed between other groups (Ricardo et al., 2013).

In present study, similar results of this study were obtained and was shown that, there is difference between two types of porcelain (2 brand types) that was used in the study only when glazing method was used by CO_2 laser in terms of surface roughness and otherwise, there is no significant difference between the types of different not glazed (only were polished) porcelain (different brands), it should be noted here that a large number of studies only survey the Ra parameter (Prasad 2009) and (Yilmaz 2010) and (Güler 2009); while due to importance and impact of the Rz parameter, some differences in this study can be justified with other studies to this reason, also this problem is demonstrator of measurement necessity of the Rz parameter to identify surface roughness more accurately. Furthermore, surveying more parameters about surface roughness as was done in this study, can provide more useful information about surface morphology to us, it should be noted that the use of the Rz parameter and ratio Rpm / Rz was essential perfectly alongside Ra parameter and using mentioned parameters in present study is another reason for difference of some findings of this study with other studies and this is the strength of present study. Also, in present study, glazed groups that were only polished had no significant difference.

Byeong-Hoon and his colleagues performed a study in 2013 and surveyed the improvement of feldspathic porcelain surface roughness by a new rubber wheels which contained uniform particles of carbide silicon and small diamond particles on two sinterd and build porcelain in CAD-CAM method. The surface roughness of both porcelains in surface polishing methods was lower than glazing method (Huaw 2013), which reasons the differences between findings of Byung-Hoonand his colleagues with present study can be known in lack of our different polishingmethods usage, using different commercial brands of materials, different used methodologies in the studies and different investigated variables.

In the present study, significant difference was not observed in their surface roughness between different porcelains with same method of glazing, but a significant difference was observed between porcelains that had been glazed with co2 laser method with porcelains that had beentypically glazed or with porcelains that had not been glazed. Sumitsethi and his colleagues surveyed and compared surface roughness inautogaze, reglaze and chair side polished method of porcelain surface in two vita vmk94 andivoclar classic porcelain in 2012. Their results showed that different types of porcelains (different brands) had no significant difference in terms of surface roughness in different glazing methods (Prasad 2009), which is confirmation of present study. As mentioned in present study, no significant difference was not observed between control groups that had been only polished in terms of surface roughness, but it was possible toobserve a similar result to study of Vieira et al, where different polishing methods were used (Vieira et al., 2013), because they observed that the lowest surface roughness is related to VM7 ceramics with polishing method with Shofu system between VM7 and VM13 ceramics that had been studied, in the study thatevaluate and surveythesurface roughness in different ways offinishing and polishing dental ceramics that also had significant difference with other groups and other methods of finishing and polishing statistically.

According to a study of Barghi and associates (1975) and study of Karaksi and associates (1993), the best mode of surface roughness that leads to smoother surface and increasedmechanical strength of the material Compared with different systems of polishing and finishing of using glazing (Barghi 1975) and (El-Karaksi 1993), that their findings areconfirmation of the results of present study based onexistenceof a significant difference between the glazed groups with not glazed groups. Fuzzi and coworkers (Fuzzi et al., 1996) also in a study that performed about evaluating surface roughness in different ways of polishing and glazing in 1996, concluded that glazing method is preferable to polishing method which their findings are confirmation of the results of present study. Also Brackett SE et al. (1989) preferred glazing method in a study that examined the effect of glazing method in porcelain strength and surface modifications (Brackett 1989). Also Al-Wahadni (2006) observed in his study that glazing causes creating a smoother surface and less surface roughness compared to different methods of finishing and polishing (Al-Wahadni 2006), although present study and many other studies are confirmation of these findings based on priority of glazing in reducing the surface roughness compared with different methods of polishing and finishing.

However, some studies, including Kelly and colleagues (1996) were presented different results, theydidn't observe significant difference about surface roughness in their study between glazing method with finishing and polishing in different ceramics (Kelly et al. 1996); demonstrated that results of these findings can be found in type of used ceramics and used polishing, finishing and glazing methods instudy and used laboratory equipment. In contrast to our findings, Sarac and coworkers (2006) demonstrated that there is no significant statistical difference between surface roughness of glazed ceramicswith polished ceramic with different systems of polishing, Furthermore, there are studies that have been claimed that the surface roughness of polished ceramicsare less than glazed ceramics, like the Hulterstro¨m et al. (1993) and NettoJu'nior et al. (2006) and Wright (2004); (Hulterström 1993) and (Wright 2004), but the findings difference can be found in used ceramics, exist-

ence of laboratory errors and used methods in glazing and polishing materials.

Also, we can claim based on mentioned studies that consensus is not available between researchers about the effects of glazing or different ways of finishing and polishing to reduce the surface roughness of ceramic and porcelains, So, existence of different and even contradictory findings in studies is not far, results can be different due to use of produced commercial different brands, different used methodologies in the studies and different investigated variables and way of porcelain preparation, for example, the temperature at which the samples are prepared in their presence can have big impact in surface roughness of samples,we should note that created temperature by thermocouple can't alwaysbe demonstrator ofreal temperature, because the surrounding temperature can cause the loss of some of these temperatures. If you have not considered this matter, it may provide different and even conflicting results about the surface roughness in different glazing methods.

Sarikaya and Güler (2010) addressed to effect of different polishing techniques at the surfaces ofdental porcelains surface roughness in a study. Their findings which is confirmation ofpresent study findings also wad showed that using glazing can reduce the surface roughness compared to other polishing methods (Sarikaya 2010). Also, Tholt et al. (2006) surveyed and measured the surface roughness of prepared dental ceramics with different finishing techniques by using Atomic Force Microscope and Profilometer, (Tholt et al., 2006). They found that there are differences betweendifferent porcelains with different ways of polishing, as well as they found as present study that glazing method causes less surface roughness compared with other finishing and polishing methods. Speed of the used method in present study for porcelain glazing, is the main advantage of this method compared to autoglazing techniques to typical method.

CONCLUSION

RZ item of porcelains surface roughness amount (Average of maximum violence height)with typical glazingwas significantly greatercompared to porcelains that were glazed by co_2 laser, although the ANOVA test between Ra, Rpm groups didn't show significant difference. Also, not glazed porcelains that had just polished, had more surface roughness significantly compared to porcelains that were glazed by co_2 laser.

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