Effect of the Different Polishing Techniques on the Surface Roughness of Dental Porcelain: An in-vitro Study

Shashank chauhan[1] ,Sunil Kumar Mishra[2] , Manoj kumar[3]

[1]*Post Graduate student, Departmemt of Prosthodontics, Rama Dental College Hospital and Research Centre Kanpur.*

[2]*Professor and Head of Department of Prosthodontics, Rama Dental College Hospital and Research Centre Kanpur.*

[3]*Associate Professor of Department of Prosthodontics, Rama Dental College Hospital and Research Centre Kanpur.*

Abstract

Introduction: Dental ceramics are widely regarded as one of the best restorative materials for the oral cavity. Ceramics are naturally chemically inert and nontoxic in nature. This study was done to evaluate the surface roughness of dental porcelain when subjected to different surface treatments i.e, glazed, reglazed and chair side polishing using porcelain adjustment kit followed by diamond polishing paste.

Material & Method: Total of50 samples of dental porcelain were fabricated using custom made metal mould with dimensions of 10mm thickness and 2mm width. Samples were randomly divided into five groups of 10 sampels each. Samples were then subjected to surface treatments viz glazed (Group I, control), abraded and reglazed (Group II), abraded and polished with porcelain adjustment kit (shofu) (Group III), abraded and polished with diamond polishing paste (Group IV), abraded and polished with combination of porcelain adjustment kit followed by diamond polishing paste (Group V).

Result: Minimum surface roughness was observed in Group II-Reglazed (0.459).

Conclusion: Ceramic restorations adjustment in dental clinics, when diamond polishing paste was used after porcelain adjustment kit, it may provide finish equal to glazed and reglazed surface.

Keywords: Chair-side polishing, Dental Porcelain, Glazed, Polishing Kit, Reglazed, Surface Roughness.

Introduction

Dental ceramics are widely regarded as one of the best restorative materials for the oral cavity. In terms of color and translucency, they closely resemble actual tooth substances.[1]Ceramic materials have emerged as a significant and growing area of dental materials, and much emphasis has been paid to their study, development, and application.[2]Any dental procedure aims to improve and preserve the quality of oral health. The key challenge is to find a restorative material that can endure the harsh conditions of the oral environment while yet maintaining function, form, and appearance. Dental porcelain restorations have improved dramatically in quality and standard during the previous two centuries. Porcelain surfaces are usually subjected to a superficial treatment known as glazing, which gives them the appearance resembling that of natural tooth. Abrasive burs are used to polish the surface, followed by a heat treatment that causes the upper layer to melt. Surface modifications are essential for correcting occlusal interferences and faulty contours, finishing the margins of ceramic restorations, and improving the esthetic appearance and surface smoothness of porcelain restorations.[3]In dentistry, easily polish able ceramic with a hardness value less than enamel is preferred to reduce the wear caused by friction between ceramic surfaces and opposing natural teeth enamel. Glazed ceramic surfaces are preferable because they strengthen fracture resistance and reduce potential abrasiveness by sealing the open pores on the surface of the fired processed porcelain. This study was conducted with an aim to evaluate the surface roughness of Dental Porcelain by using different surface treatments in-vitro.

Material and Methodology

This study was conducted with the objective of evaluating the effect of different surface treatments on the surface roughness of porcelain. In this investigation, fifty circular-shaped samples were fabricated.

a) **Fabrication of mould:** To achieve a standardized layer of body porcelain of equal thickness, a customized mould of dimension l0mm diameter and 2mm thickness was fabricated

b) **Sample fabrication technique:** Samples were prepared by mixing an equal amount of Vita

Master Shade A2 porcelain powder with distilled water and was loaded in the manufactured mould it was placed over the glass slab with a little clean flat brush. Excess water was removed with tissue paper before addition of the next increment. Mixed mass was not completely dried during moisture absorption. After complete condensation, samples were removed from the mould and placed on a sagger tray which was placed on the porcelain furnace. Firing schedule is

1) Drying was done outside the muffle for 5 min at 650° C.
2) Pre-heating was done at 650° C inside the muffle for 5 min.
3) Increasing the temperature from 650 to 930°Cat 55° C/min under the vaccum of 29mm Hg for about 1min.

After cooling, dentin shade (A2) and enamel ceramic shade of (ENI) shade layer were applied surface of ceramic to compensate shrinkage thereafter firing was done. Measurement of the samples was done by means of a digital vernier caliper (ABN Finest Ltd, Measuring Digital Caliper, India) with a diameter of 10mmand 2mm thickness. 50 samples were prepared in the same manner. After cooling, all the samples were finished and polished using a medium grit diamond bur (Shofu) for removal of surface irregularities The porcelain glazing powder was mixed with liquid using a thin brush a thin layer of glaze was applied by giving a single stroke on one side of each specimen.

c) Formation of groups (TABLE-1)

	Group I	Group II	Group III	Group IV	Group V
Total Samples	10	10	10	10	10
Treatment	Glazed (Control)	Abraded and then Reglazed	Abraded and then Polished With Porcelain adjustment Kit	Abraded and then Polished with diamond polishing paste.	Abraded and then Polished with porcelain adjustment kit and Diamond polishing paste

d) Testing of the samples: After the procedures, assessment of all the samples was done for surface roughness (Ra) by using a Profilo meter where the parameter, Ra, was calculated. This was done with the physical probe by which stylus tracing is done. a represents the surface roughness and is calculated as the average roughness of a surface measured microscopic spikes and velleys. Image of same height was generated as profilometer. The size of the specimen was measured and the size of the probe was set to upper and lower limits on the size of the features that can be characterized. Sample stabilization was done in a stainless steel metal mould and three measurements of roughness (Ra) were taken. A pick-up with a diamond stylus (5 µm tip radius) was used under a constant pressure force of 4 mN witha tip angle at 90°. The instrument was calibrated using a standard reference specimen (ISO 1997) and was set to travel at speed of 0.5mm/s with a traversing length of 0.25mm during testing. Ra value was assessed using, diamond detector unit or stylus which was moved over the surface of the specimen under a constant load of 4mN.The surface analyzer was used for the determination of the roughness profile of each specimen at three different locations to obtain the general surface characteristics. The mean value of these three measurements was determined for each specimen. A lower Ra value describes a smoother surface. The roughness profile of the glazed, reglazed and the chair side polished surface was obtained for each of the 3 passes. Three different values were chosen. The stylus was first used to evaluate the surface roughness of the treated sample in the horizontal direction of the specimen's surface trajectory, and then it was moved to a different place in the vertical direction.

Statistical analysis

Mean change in surface roughness ± standard deviation of all specimens in each group was tabulated. One-way ANOVA followed by Post Hoc tukey's Test HSD was applied to statistically analyse the data obtained from profilometer.

Results and observations

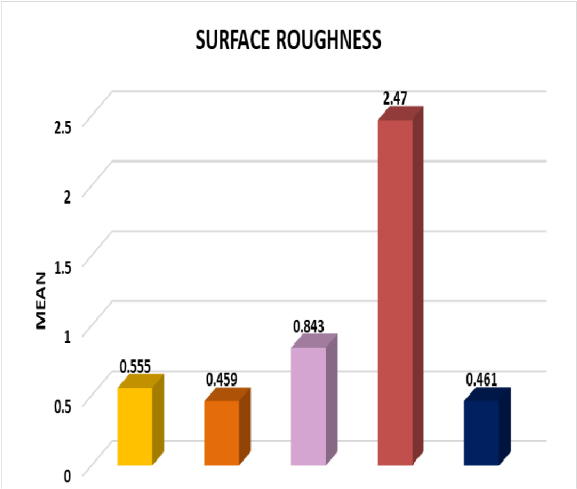
Table 2 and Graph 1 shows mean surface roughness (Ra) value of all five group streate d with different surface treatments on dental porcelain. Minimum surface roughness was observed in Group II-Reglazed (0.459), followed by Group V-Chair-side polished with both adjustment kit and diamond

polishing paste (0.461), Group I-Glazed (0.555), Group III-Chair-side polished with adjustment kit (0.843)and Group I-Chair-side polished with diamond polishing paste (2.47).

Table 2: Descriptive of mean surface roughness (inμm) among different study groups

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min.	Max.
					Lower Bound	Upper Bound		
Group I	10	.5550	.02953	.00934	.5339	.5761	.51	.61
Group II	10	.4590	.02726	.00862	.4395	.4785	.41	.50
Group III	10	.8430	.06567	.02077	.7960	.8900	.69	.90
Group IV	10	2.4700	.27101	.08570	2.2761	2.6639	2.10	2.90
Group V	10	.4610	.05507	.01741	.4216	.5004	.40	.56
Total	50	.9576	.78662	.11124	.7340	1.1812	.40	2.90

Graph 1: Descriptive of mean surface roughness (in micro m) among different study groups



Statistically significant difference was observed in mean surface roughness of different study groups when compared using One way ANOVA as $p<0.05$.

Table 3: Intergroup comparison of mean surface roughness using

	Sum of Squares	df	Mean Square	F	Sig.
Between the Groups	29.578	4	7.394	448.669	.0001*
Within the Groups	.742	45	.016		
Total	30.320	49			

Multiple comparison were done to evaluate the roughness of all groups by Post hoc test it showed smoothness of samples in the following order. Group II> Group V>Group I>Group III>Group IV.

Table 4: Post hoc pair wise comparison

Pair wise comparison	Mean Diff.	Std. Error	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
I VS II	.096	.05741	.461	.0671	.2591
I VS III	-.288*	.05741	.000*	.4511	-.1249
I VS IV	-1.915*	.05741	.000*	-2.0781	-1.7519
I VS V	.094	.05741	.482	-.0691	.2571
II VS III	-.384*	.05741	.000*	-.5471	-.2209
II VS IV	-2.011*	.05741	.000*	-2.1741	-1.8479
II VS V	-.002	.05741	1.00	-.1651	.1611
III VS IV	-1.627*	.05741	.000*	-1.7901	-1.4639
III VS V	.382*	.05741	.000*	.2189	.5451
IV VS V	2.009*	.05741	.000*	1.8459	2.1721

*-statistically significant difference

Discussion

Intraoral ossifying Ceramic is a rapidly growing in dental materials research because of its property which matches the natural tooth color, biocompatibility, chemical inertness, and high resistance to wear.[4] Despite of that Ceramic material inherently it has multiple flaws due to inhomogeneous distribution of the crystals in glassy matrix. An additional defect during ceramic processing steps reduces the strength and increase the wear of enamel surface of opposing tooth. Sealing these defects with glazing or chair-side polishing may improve the strength and reduce the abrasion of dental ceramics.[5]Even today, many dentists prefer to reglaze the corrected porcelain surfaces before cementation. A lot of research has looked into the best finishing and polishing techniques for achieving

the best smoothness in glazed porcelain. These researches were carried out in order to find a finishing and polishing procedure that would provide surfaces that were as smooth as or smoother than glazed porcelain. The outcomes were diverse. Some people thought the initial smoothness was better than the polished surfaces [6,7,8] some said no significant difference was seen between the glaze and polished surfaces[9,10] and others concluded that surface polishing could equal or surpass the smoothness accomplished with surfaces glazing[11,12,13] Due to the numerous disadvantages of reglazing, it has become necessary to investigate alternate methods of polishing ceramic surfaces that would produce equivalent or superior aesthetic and functional results. An extra firing cycle may cause marginal distortion- Balkaya MC et al[14]investigated the effect of porcelain and glaze firing cycles on the fit of three different types of all ceramic crowns. They discovered that the highest marginal disagreement occurred during the porcelain firing cycle, and that while the discrepancy is reduced during glaze firing. Extra firing cycle leads to Devitrification After multiple firings, porcelain surfaces frequently become turbid and milky. According to Jacobi et al, a few experts proposed that coating be purposely removed from the obstructing surfaces due to the fact that the coated surface was harder than the basic porcelain and hence likely more grating. They also claimed that a thoroughly cleaned surface was less abrasive than covered porcelain.[15] Mona sky and Taylor revealed practical cleaning of porcelain during the wear process in a sliding wear test.[16] They discovered that the high rate of wear at first decreased after some time, implying that the impact of surface discomfort on wear may be self-restricting. To accomplish a normalized layer of body porcelain of equivalent thickness, a tweaked shape of aspect 10mm x 2mm (10mm width and 2mm thickness) was manufactured. Wright MD et al[17] and Yilmaz Ket al18also used the same dimension for fabrication of the mould. Klausner LH et al[19], Wright MD et al[20], ZalkindM et al[21], Goldstein GR et al[22], Scurria MS et al[23], and Magne Pet al[24] have additionally utilized the profilometer in their studies. This is utilized to decide geographical information from example surface. In the current study the polishing done with porcelain adjustment kit alone showed more surfaces roughness than other surface treatment. The same results were seenin the study of Haralur S Band Sarac D, who concluded that shofuporcelain adjustment kit has the ability to decrease the surface roughness of dental porcelain samples. But dental porcelain adjustment kit alone cannot be the alternative of reglazing.The findings of the current review appear to be significant from understanding the impact of coating and reglazing and seat side cleaning on the surface harshness of rubbed dental porcelain.

Conclusion

Chair side polishing of dental porcelain with combination of adjustment kit and polishing paste (diamond) can be a good alternative to realizing after adjustment of ceramic restorations in dental clinics.

References

1. Vieira AC, Oliveira MC, Lima EM, Rambob I, Leite M. Evaluation of the surface roughness in dental ceramics submitted to different finishing and polishing methods. J IndProsth Soc. 2013; 13(3):290-295.
2. Anusavice KJ. Philip's science of dental materials. 10th ed. Philadelphia: WBsaunders; l 996.p.33, 69-71, 598-600.
3. Sethi S, Kakade D, Jambhekar S, Jain V. An in vitro investigation to compare the surface roughness of auto glazed, reglazed and chair side polished surfaces of Ivoclar and Vita feldspathic porcelain. J Indian Prosthodont Soc 2013; 13(4):4 78-85.
4. Anmol C, Soni S. Effect of two different finishing systems on surface roughness of feldspathic and fluorapatite porcelains in ceramo-metal restorations: Comparative in vitro study. JISPCD 2014;4(1):22-28
5. Oh W, Delong R, Anusavice KJ. Factors affecting enamel and ceramic wear: A literature review. J Prosthet Dent 2002; 87:451-459.
6. Klausner LH, Cartwright CB, Charbeneau GT. Polished versus autoglazed porcelain surfaces. J Prosthet Dent 1982; 47:157-162.
7. Campbell SD. Evaluation of surface roughness and polishing techniques for new ceramic materials. J Prosthetic Dent 1989; 61:563-568.
8. Patterson JW, McLundie AC, Stirrups DP, Taylor WG. Refinishing of porcelain by using a refinishing kit. J Prosthet Dent 1991; 65:383-388.
9. Brewer JD, Garlapo DA, Chipps EA, Tedesco LA. Clinical discrimination between auto glazed and polished porcelain surfaces. J Prosthet Dent 1990; 64:631-635.
10. Sulik WD, Plekavich EJ. Surface finishing of dental porcelain. J Prosthet Dent 1981; 46:217-221.
11. Jagger DC, Harrison A. An in vitro investigation into the wear effects of unglazed, glazed, and polished porcelain on human enamel. J Prosthetic Dent l 994;72:320-323
12. Haywood VB, Heymann HO, Kusy RP, Whitley JQ, Andreaus SB. Polishing porcelain veneers: an SEM and specular reflectance analysis. Dental Materials 1988; 4:116-121.
13. Haywood VB, Heymann HO, Scurrira MS. Effect of water, speed a experimental instrumentation on finishing and polishing porcelain intraorally. Dent Mater 1989; 5:185-188.
14. Balkaya MC, Cinar A, Pamuk S. Influence of firing cycles on the margin distortion of 3 all-ceramic crown systems. J Prosthet Dent 2005; 93:346-355.

15. Jacobi R, Shillingburg HT, Duncanson M. A comparison of the abrasiveness of six ceramic surfaces and gold. J Prosthet Dent 1991; 66:303-309.
16. Monasky GE, Taylor DF. Sh1dies on the wear of porcelain, enamel and gold. J Prosthet Dent 1971; 25:299-306.
17. Wright MD, Masri R, Driscoll CF, Romberg E, Thompson GA, Runyan DA. Comparison of three systems for the polishing of ultra-low fusing dental porcelain. J Prosthet Dent 2004;92(5):486-490.
18. Yilmaz K, Ozkan P. Profilometer evaluation of the effect of various polishing methods on the surface roughness in dental ceramics of different structures subjected to repeated firings. Quintessence Int 2010; 41(7): 125-13 l.
19. Klausner LH, Cartwright CB, Charbeneau GT. Polished versus auto glazed porcelain surfaces. J Prosthet Dent 1982; 47:157-162.
20. Wright MD, Masri R, Driscoll CF, Romberg E, Thompson GA, Runyan DA. Comparison of three systems for the polishing of ultra-low fusing dental porcelain. J Prosthet Dent 2004;92(5):486-490
21. Zalkind M, Lauer S, Stern N. Porcelain surface texture after reduction and natural glazing. J Prosthet Dent 1986; 55:30-33.
22. Goldstein GR, Baranhard BR, Penugonda B. Profilometer, SEM and visual assessment of porcelain polishing methods. J Prosthet Dent 1991; 65:627-634.
23. Scurria MS, Powers JM. Surface roughness of two polished ceramic materials. J Prosthet Dent 1994;7 l: 174-7. Edge JM, Wagner WC. Surface cracking identified in polished and self-glazed dental porcelain. J Prosthodont 1994; 3: 130-133.
24. Magne P, Won-suck OH, Pintado MR, Delong R. Wear of enamel and veneering ceramics after laboratory and chairside finishing procedures. J Prosthet Dent l 999; 82:669-679.

To cite this article: Effect of the Different Polishing Techniques on the Surface Roughness of Dental Porcelain: An in-vitro Study: Shashank chauhan, Sunil Kumar Mishra, Manoj kumar, Rama Univ. J. Dent. Sci. 2022 March; 9 (1): 10-14