

The Evaluation and Comparison of Topical NaF & Stannous Fluoride on Surface Roughness of Dental Porcelain: In Vitro Study

Purushotam Kumar^{1*} Archana Jalheria² G.S. Chandu³ Sunil Kumar Mishra⁴ Sonali Rai⁵ Mohd Faisal Khan⁶

¹Consultant Prosthodontist & Implantologist, Motihari, Bihar, India.

²Senior Lecturer, Department of Prosthodontics, PCDS & RC, Bhopal, India.

³Professor, Department of Prosthodontics, RCDS & RC, Bhopal, India.

⁴Professor, Department of Prosthodontics, PCDS & RC, Bhopal, India.

⁵Private Practitioner, Patna, Bihar, India.

⁶Senior Lecturer, Department of Prosthodontics, RCDS & RC, Bhopal, India.

ABSTRACT

Aim: The present study was conducted to determine the effect of commonly used topical fluorides on the surface of porcelain fused to metal restorations.

Materials and Methods: Total 100 porcelain fused metal specimens of were prepared and divided into two group of 50 sample each. The specimen were immersed in sodium fluoride 0.04% and stannous fluoride 0.4% for 2 minute, 4 minute, 14 minute, 1 hour and 12 hour (considering 14 min = 1 week, 1 hour = 1 month, 12 hour = 1 year). The wax covering was removed and specimens were washed under running tap water and air dried. After the time period specimens were assessed for surface roughness analyzer at 2 point in both experimental and controlled group, the reading were recorded in micrometer and the data was statically analyzed using one way ANOVA test.

Results: NaF gel have significant difference in surface roughness of dental porcelain in different time periods ($P < 0.05$). And according to mean surface roughness increased in 4 minutes but after that surface roughness progressively decreased with time. Stannous Fluoride Gel have no significant difference in surface roughness of dental porcelain in different time periods ($P < 0.05$).

Conclusion: All fluoride solutions causes that roughening of porcelain.

Keywords: Ceramic, Surface Roughness, NaF, Stannous Fluoride.

INTRODUCTION

Topical applications of NaF gel reduce the incidence of caries. Repeated exposures of porcelain or composite restorations to NaF preparation can result in material loss, surface roughening, and corresponding changes in esthetic appearance. Dental porcelain that were subjected to prolonged immersions or repeated applications of NaF preparations in in-vitro studies showed increase in surface roughness using photography, topical and scanning electron microscopy, and surface profiler analysis. Non-acidic fluoride preparations that are

effective in reducing caries incidence are available. Their use might be considered for patients with extensive porcelain or composite restorations who require fluoride treatment.¹

Long term fluoride application, on the teeth of patients receiving radiation therapy for head and neck tumors in excessive staining and roughening of ceramic restorations.² The use of fluoride in the control of dental caries is based on the observation made by Dean in 1938, that the percentage of

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*Correspondence Dr. Purushotam Kumar.

Consultant Prosthodontist & Implantologist, Motihari, Bihar, India.

Email: drpurushotamkumar009@gmail.com

caries-free children in communities where domestic water supplies contain higher concentration of fluoride was higher than in communities using waters of lower fluoride concentration.³

There is substantial evidence that the presence of fluoride in the mouth encourages re-mineralization of early lesion.^{4,5} Fluorides may also alter bacterial metabolism and they have the potential to combat periodontal disease.⁶ They are also useful for patients with xerostomia or whose salivary activity has been compromised by irradiation, medication, Sjogren's syndrome or surgery.⁷ The two major fluoride compounds used in professional topical preparations are sodium fluoride, stannous fluoride.⁸ Dental porcelain consists primarily of glasses, porcelain, glass-ceramics, or highly crystalline structures.⁹ The highly glazed surfaces of porcelain restorations can be etched and roughened by repeated application of fluoride.¹⁰ the purpose of this study is to evaluate and compare the effect of topical fluorides on surface roughness of dental porcelain.

MATERIALS AND METHODS

Wax pattern measuring approximately 10 mm x 10 mm x 2 mm was fabricated using modeling wax (200). The wax pattern used was 2.00 mm spruing wax (Bego). The wax pattern was vacuum invested with a phosphate bonded investment material (Bellasum). The conventional lost-wax casting technique was used. The wax burnout temperature was 8500 C. The castings were then sand blasted. The sprue was cut using a T-separating disk. The specimens were then sandblasted and rinsed under running tap water and were air-dried. Porcelain (vita-VMK 95.) was then baked onto the metal substructure according to the manufacturer's instructions. After sandblasting the specimens were washed under running tap water, and air dried. Then the specimens were subjected to oxidation cycle at 980° C under vacuum in the ceramic furnace. As per the manufactures instructions each layer of the vita-VMK porcelain was applied.

The specimens were cleaned under running tap water and then air-dried. Then the glaze was applied and fired. The porcelain was masked on half of the surface with modeling wax, which acts as control. The unmasked surface was the experimental surface. The specimens were then

immersed in the different fluorides for varying time intervals. An area of 0.5 mm on either side of experimental and control junction was not used. The stylus moved vertically and measured the average surface roughness. The measurements were made at two different areas of each specimen on both the experimental and the control surfaces.

A total of 100 samples were made. Out of which 50 samples were immersed in the NaF gel 10 each for 2min, 4min, 14 minutes, 1 hours, and 12 hours [considering 14 min=1week, 1 hour=1month, 12 hour= 1 year]. After which the specimens were washed under running tap water and air-dried. Similarly the specimens were immersed in the other test fluoride solutions 10 specimens for 2 minutes, 4 minutes, 14 minutes, 1 hour, and 12 hours. The surface roughness was measured using a surface roughness analyzer. The data obtained was subjected to statistical analysis with the consult of a statistician. The data obtained was complied systematically.

Statistical procedure was carried out in 2 steps:

1. Data compilation and presentation
2. Statistical analysis.

Statistical analysis of data is done by help of SPSS 20.0 Software (trial Version) and One Way ANOVA test is use in data analysis

RESULTS

Table 1 shows:

In 2 Minutes: There is significant difference in surface roughness of dental porcelain in different medicament ($P < 0.05$). and according to mean surface roughness is higher in Stannous Fluoride Gel followed by Di-ionized Distilled Water.

In 4 Minutes: there is significant difference in surface roughness of dental porcelain in different medicament ($P < 0.05$) . and according to mean surface roughness is higher in NaF Gel followed by Stannous Fluoride Gel.

In 14 Minutes: there is significant difference in surface roughness of dental porcelain in different medicament ($P < 0.05$) . And according to mean surface roughness is higher in NaF Gel followed by Stannous Fluoride Gel.

In 1 Hours: there is significant difference in surface roughness of dental porcelain in different medicament ($P>0.05$).

In 12 Hours : there is significant difference in surface roughness of dental porcelain in different

medicament ($P<0.05$) . And according to mean surface roughness is higher in Acidulated phosphate fluoride Gel (APF) followed by Stannous Fluoride Gel.

Table 1: Comparison of effect of topical fluoride on surface roughness of dental porcelain according to different time periods.

		N	Mean	Std. Deviation	F value	P value
In 2 Minutes	NaF Gel	10	0.5472	0.11925		
	Stannous Fluoride Gel	10	0.9076	0.17228	20.878	<0.0001*
	Untreated	10	0.4685	0.11437		
	Total	30	0.7244	0.19972		
In 4 Minutes	NaF Gel	10	1.3888	0.21558		
	Stannous Fluoride Gel	10	0.9391	0.14564		
	Untreated	10	.4585	.11447		
	Total	30	0.9404	0.31433		
In 14 Minutes	NaF Gel	10	1.0423	0.15198		
	Stannous Fluoride Gel	10	0.9252	0.15539		
	Untreated	10	.4685	.11437		
	Total	30	0.8693	0.19059		
In 1 Hours	NaF Gel	10	0.8214	0.09973		
	Stannous Fluoride Gel	10	0.7968	0.16321		
	Untreated	10	.4685	.11437		
	Total	30	0.8107	0.10251		
In 12 Hours	NaF Gel	10	0.7533	0.19447		
	Stannous Fluoride Gel	10	1.0374	0.22580		
	Untreated	10	.4685	.11437		
	Total	30	0.9279	0.28593		

Table 2shows:

1. NaF Gel: there is significant difference in surface roughness of dental porcelain in different time periods ($P<0.05$).

2. Stannous Fluoride Gel: there is no significant difference in surface roughness of dental porcelain in different time periods ($P<0.05$)3. 3

3.Untreated: there is No significant difference in surface roughness of dental porcelain in different time periods ($P>0.05$)

DISCUSSION

Ceramics have become a popular restorative material and used extensively in fixed restoration

due to its natural like appearance. Caries control is necessary for the long term success of restoration Hence Patient with ceramic restoration may be treated with fluoride preparations in the form of topical application or fluoride mouth rinses. Ideally ceramic restoration should retain their surface glaze even under function in oral environment, where they are exposed to various food substances and acidic solutions. Etching of ceramic surfaces can occur on exposure to these acidic solutions resulting in a rough surface, which affects the esthetics and enhances the plaque accumulation.

Table2: Comparison of effect of topical fluoride on surface roughness in different time periods

		N	Mean	Std. Deviation	F Value	P value
NaF Gel	2 Minutes	10	0.5472	0.11925		
	4 Minutes	10	1.3888	0.21558		
	14 Minutes	10	1.0423	0.15198	39.031	<0.0001*
	1 Hours	10	0.8214	0.09973		
	12 Hours	10	0.7533	0.19447		
	Total	50	0.9106	0.32863		
Stannous Fluoride Gel	2 Minutes	10	0.9076	0.17228		
	4 Minutes	10	0.9391	0.14564		
	14 Minutes	10	0.9252	0.15539		
	1 Hours	10	0.7968	0.16321	2.415	0.063
	12 Hours	10	1.0374	0.22580		
	Total	50	0.9212	0.18455		
Untreated	2 Minutes	10	0.4685	0.11437		
	4 Minutes	10	0.4685	0.11437		
	14 Minutes	10	0.4685	0.11437	0.000	1.000
	1 Hours	10	0.4685	0.11437		
	12 Hours	10	0.4685	0.11437		
	Total	50	0.4685	0.11437		

The fluoride treatment was proved to beneficial to natural teeth by inhibiting dental caries, but at the same time it causes adverse effects of dental porcelain. Topical fluoride agents are known to cause surface changes and weight loss of dental materials including porcelain, glass-ionomer and composite restorations. These dental materials are composed of glass-like elements susceptible to reaction at acidic pH.³

Hence the present study was conducted to evaluate the effects of topical fluorides on porcelain. The results showed significant differences in surface roughness of all the material (sodium fluoride gel, stannous fluoride gel) test surface as compared to control surface.

While analyzing NaF Gel immersed samples, there was a significant difference in surface roughness of dental porcelain in different time periods ($P < 0.05$). According to mean surface roughness increased in 4 minutes but after that surface roughness progressively decreased with time as shown in table 2. This is attributed to the fact that a sodium fluoride gel acidifies with orthophosphoric acid which are effective in inhibiting carries when applied topically. However, the hydrogen ion from

the acid reacts with the fluoride ions from sodium fluoride to produce hydrofluoric acid. This acid is known to etch glass which is a major component of porcelain.

The significance of the mean surface roughness of the specimens immersed in 0.4% stannous fluoride for 2minutes, 4 minutes, 14 minutes, 1 hours and 12 hours was calculated. The results showed no significant difference in surface roughness of the test surface as compared to control surface.

These results are in agreement with the findings of Richard C. Wunderlich, Peter Yaman ⁶.

The significant difference in roughness of ceramic surfaces can be contributed to the fact that by design, dental porcelain contains a large glass component that can be easily etched and pitted by the attack of fluoride ions on the silicon-oxygen network.

CONCLUSION

Within the limitation of the study, it is concluded that

1. Both fluoride solutions cause roughening of porcelain.
2. The NaF gel causes more amount of roughening of surface as compound to other fluoride solutions over a period of time.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

1. Council on dental therapeutics status report: effect of acidulated phosphate fluoride on porcelain and composite restorations. J Am Dent Assoc 1988;116: 115.
2. Artopoulou II, Power JM, Chamber MS. In-vitro Staining effect of stannous fluoride and sodium fluoride on ceramic material. The Journal of prosthetic Dentistry 2005;103(3):163-169.
3. Gron P. Chemistry of topical fluorides. Caries Res 1977; 11 (suppl.1): 172-204.
4. Duckworth RM, Morgan SN. Oral fluoride retention after use of Fluoride Dentifrices. Caries Res 1991; 25:123-129.
5. Rolla G, Saxegaard E. Critical evaluation of the composition and use of topical fluorides, with emphasis on the role of calcium fluoride in caries inhibition. J Dent Res 1990; 69 (spec Issue): 780-785.
6. Wunderlich RC, Yaman P. In vitro effect of topical fluoride on dental porcelain. J Prosthet Dent 1986; 55(3): 385-388.
7. Copps DP, Lacy AM, Curtis T, Carman JE. Effects of topical fluorides on five low-fusing dental porcelains. J Prosthet Dent 1984; 52(3): 340-343.
8. Kula K, Kula TJ. The effect of topical APF foam and other fluorides on veneer porcelain surfaces. Pediatr Dent 1995; 17(5): 356-61.
9. Anusavice KJ, Phillips – science of dental materials. Eleventh edition.2003, Dental Ceramics 655-714.
10. Sposetti VJ, Shen C, Levin AC. The effect of topical fluoride application on porcelain restorations. J Prosthet Dent 1986; 55(6): 677-682.