



## The Effect of Topical Fluoride on Glazed and Auto-Glazed Porcelain

**Omran Omar Turbi\***

Lecturer, Prosthodontics Department, Faculty of Dental Medicine, Benghazi University, Libya

\*Corresponding Author: Omran Omar Turbi, Lecturer, Prosthodontics Department, Faculty of Dental Medicine, Benghazi University, Libya.

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### Abstract

**Introduction:** For many years both water fluoridation and topical fluoride treatments have been effective approaches to reducing the solubility of tooth mineral and decreasing the incidence of dental caries. Presently, special topical application of fluoride programs is used for patients who are undergoing prosthodontics therapy, receiving irradiation treatment for head and neck malignancy, and for those who have a high incidence of caries. Most of the investigations involving the anti-caries effect of fluoride have focused on the reduction of enamel solubility rather than investigating the effect of fluoride on the restorative material that already exists in the oral cavity. Although there are some observations on the effect of fluorides on the adhesive properties to certain materials, such as composite materials used for a variety of clinical situations, there is a growing need for more studies concerning the effect of fluorides on restorative materials which are concerned with porcelain esthetics specifically. It was the purpose of this study to investigate the effects of the application of topical fluorides and/or the different pH of the saliva on the autoglazed and/or overglazed porcelain surface.

**Methodology:** Sixty samples were prepared of porcelain fused to non-precious metal. Sixty circular metal disks were used to bake a 2 mm. thickness of porcelain, following the manufacturer's recommendations (Appendix I, 11 and III).

A rectangular 3 x 3 mm. area were prepared by utilizing all finishing porcelain fused-to-metal. All sixty samples were in a high-bisque stage at the beginning of the study. Thirty samples were autoglazed and the other thirty samples were overglazed. Each sample was numbered and weighted using a "Sartorius Balance". There were six groups, each group consisting of ten samples; (5 autoglazed and 5 overglazed samples).

These groups were treated as follows:

- **Group I:** Samples immersed in pH5 media.
- **Group II:** Samples immersed in pH7 media 25 days for the length of the study.
- **Group III:** Samples immersed in 0.5% acidulated phosphate fluoride from 1.1% of (NAF) for one hour and then stored 23 hours in pH5 media.
- **Group IV:** Samples immersed in 0.4% Sn2F for one hour and then stored in pH5 media for 23 hours.
- **Group V:** Samples immersed in 0.5% acidulated phosphate fluoride from 1.1% NaF for one hour and then stored in pH7 media for 23 hours.
- **Group VI:** Samples immersed in 0.4% Sn2F for one hour and then stored in pH7 media for 23 hours.

These procedures in Group III, Group IV, Group V and Group VI, were repeated for 25 days. At the end of the study, all samples were washed in distilled water, dried in a vacuum oven for 48 hours and weighed using a "Sartorius Balance". From the pre- and post-immersion weights, the differences were calculated. The results showed that the acidulated phosphate fluoride associated with pH 5 media has the greatest destructive effect on porcelain surfaces.

These results were analyzed and subjected to analysis of two-way co-variance. The data showed a very small portion of porcelain loss, due to the application of fluoride associated with different pH. The results of co-variance showed that the data were not statistically significant throughout the study period. However, clinically, a chance of significant difference might be obtained by prolonging the time of treatment obtained.

**Keywords:** Topical Fluoride; Glazed; Auto-Glazed Porcelain

## Introduction

For many years both water fluoridation and topical fluoride treatments have been effective approaches to reducing the solubility of tooth mineral and decreasing the incidence of dental caries. Presently, special topical application of fluoride programs is used for patients who are undergoing prosthodontics therapy, receiving irradiation treatment for head and neck malignancy, and for those who have a high incidence of caries. Most of the investigations involving the anti-caries effect of fluoride have focused on the reduction of enamel solubility rather than investigating the effect of fluoride on the restorative material that already exists in the oral cavity.

Although there are some observations on the effect of fluorides on the adhesive properties to certain materials, such as composite materials used for a variety of clinical situations, there is a growing need for more studies concerning the effect of fluorides on restorative materials which are concerned with porcelain esthetics specifically.

Therefore, this present laboratory study investigated the effect of fluoride on auto glazed and overglazed porcelain fused-to-metal and at the same time, this investigation studied and compared the effect of different pH of saliva on auto glazed and over glazed porcelain.

## The Statement of the Problem

### The Purpose of the Study

Based on a review of the literature, it has been noticed that the porcelain fused to metal restorations in irradiated patients discolors when they are subjected to daily fluoride treatment due to the etching and breakdown of the porcelain surface. Therefore, the purpose of this investigation was to study and compare the effects of acidulated phosphate fluoride (0.5%), stannous fluoride (0.4%), and different pH values (pH 5 and pH 7) on the auto glazed and/or overglazed porcelain surfaces. We tested to see if this effect was due to the change in the pH of the saliva of irradiated patients, which in most cases reached pH 5, as stated by Frank [1]. or was due to the direct effect of the fluoride on the porcelain surface.

In this investigation the effect of acidic and neutral media was correlated with the direct effect of the fluoride on the autoglazed and overglazed porcelain specimens. This correlation was quantitatively measured by noting the weight differences after the sam-

ples were immersed for specified periods of time in different pH values and treated with different fluorides.

### Null Hypothesis

There is no change in the autoglazed and/or overglazed surfaces of the porcelain due to topical application of fluorides and/or different pH of saliva.

### Preliminary Hypothesis

There is a change in the autoglazed and/or overglazed surfaces of the porcelain due to the topical application of fluorides and/or different pH of saliva.

### Significance of the Study

Assuming that the topical application of fluoride and/or different pH of saliva has an effect on the auto-glazed and/or over-glazed surface of porcelain, this study will aid the practicing dentists and give some guidelines on the use of topical fluorides in relation to porcelain as a very important restorative material in dentistry, especially when aesthetics is of prime importance.

## Methods and Materials

### Preparation of Samples

Sixty samples of porcelain<sup>1</sup> fused-to-non-precious metal<sup>2</sup> were used in this investigation. These samples were prepared as follows:

- Circular metal disks were utilized to bake a 2 mm. thickness of porcelain following the manufacturer's recommendation (Appendixes I, II, III).
- A rectangular 3 x 3 mm area was prepared by utilizing all finishing tools that are commonly used in finishing porcelain fused to metal.
- All 60 samples were in the high-bisque stage at the beginning of the study. Thirty samples were autoglazed and the other 30 samples were overglazed.
- All samples were washed in distilled water and dried in a vacuum oven<sup>3</sup> for 48 hours. Each sample was numbered and weighed using Sartorius Balance (Automatic pre-weighing models)<sup>4</sup>.

### Sample Treatment

There were 6 groups, each group consisted of 10 samples; (5 autoglazed and 5 over-glazed) (Table 1).

#### Group I

Five samples of the autoglazed and five samples, of the overglazed were immersed in pH 5 media for 25 days; the length of

<sup>1</sup>Biobond porcelain, Dentsply International, York, PA.

<sup>2</sup>C and B Alloydentsply International, York, PA.

<sup>3</sup>Thelco Model 19, Precision Scientific Company, G.C.A. Corporation, N.Y., N.Y.

<sup>4</sup>Sartorius Balances, Brinkmann Instruments, Inc., Westbury, N.Y.

Media	Overglazed	Autoglazed
pH 5 (Buffered)*	5	5
pH 7(Buffered)*	5	5
**APF + pH 5	5	5
**APF + pH 7	5	5
Sn <sub>2</sub> F + pH 5	5	5
Sn <sub>2</sub> F + pH 7	5	5

**Table 1:** Sample Treatment Groups.

\*Buffered pH 5 and Ph 7, Fisher Scientific Co., Pittsburgh, PA.

\*\* Acidulated Phosphate Fluoride 0.5% from sodium fluoride 1.1%.

the experiment period. The use of pH 5 media was to simulate the saliva in the irradiated patient [1] (Table 2).

**Group II**

Five samples of the autoglazed, five samples of the overglazed were immersed in a pH 7 media for 25 days (the length of the experiment period). The pH 7 acted as a normal saliva.

**Group III**

Five samples of the autoglazed and 5 samples of the overglazed were immersed in 0.5% APF (from 1.1% sodium fluoride)<sup>5</sup> for one hour, next washed thoroughly in distilled water and scrubbed with a tooth brush, then stored in a pH 5 media for 23 hours. This procedure was repeated for 25 days and simulated clinical application of fluoride in irradiated patients. Patients who received irradiation treatment were using topical fluoride 5 minutes per day; in this study it was for one hour/day for 25 days, which is equivalent to 300 days of clinical use.

pH Measurements of Intervals After Beginning of Irradiation Therapy							
Individual measurement	pH before irradiation	2 weeks.	One month	2-3 months	4-5 months	6 months- 1 yr.	2-6 year
	6.45	4.85	6.45	4.95	6.95	5.95	5.55
	6.85	5.84	7.10	6.05	5.75	4.05	6.70
	7.10	6.40	6.50	6.65	5.20	4.95	5.90
	6.10	5.15	5.95	5.50	4.85	6.35	5.25
	6.70	6.25	5.75	4.85	5.75	6.25	6.05
	6.80	6.30	6.45	6.35	5.85	5.65	7.95
	5.90	5.75	--	4.05	6.50	5.85	5.45
	6.40	5.60	--	--	--	6.75	6.00
	6.55	6.45	--	--	--	6.05	5.65
Mean	6.54	5.85	6.36	5.48	5.83	5.76	6.05

**Table 2:** Saliva pH of patients with carcinomas of oral cavity and oro-pharynx before irradiation and 2 weeks to 6 years after beginning of radiation therapy.

Adapted from Frank, J. of Amer. Dent. Assn., Vol. 79, April 1965 [1].

**Group IV**

Five samples of autoglazed and 5 samples of overglazed were immersed in 0.4% stannous fluoride<sup>6</sup> for one hour, next washed thoroughly-in distilled water and scrubbed with a tooth brush, then stored in a pH 5 media for 23 hours. This procedure was repeated for 25 days and simulated clinical application of fluoride in irradiated patients for about 300 days of clinical use.

**Group V**

Five samples of autoglazed and 5 samples of over glazed were immersed in 0.5% APF (from 1.1% sodium fluoride) for one hour, next washed thoroughly in distilled water, then scrubbed with a tooth brush before being stored in pH 7 media for 23 hours. This procedure was repeated for 25 days to simulate clinical application of fluoride in patients with normal saliva of pH 7.

<sup>5</sup>Gel-Kam = 0.4% stannous fluoride gel, Scherer Laboratories, Inc., Dallas", TX.

<sup>6</sup>Karigel = Topical Acidulated Phosphate fluoride 0.5% fluoride ion (from 1.1% sodium fluoride) 0.1 molar phosphate, pH 5.6. The Lorvic Corporation, St. Louis, MO.

### Group VI

Five samples of autoglazed and 5 samples overglazed were immersed in 0.4% stannous fluoride for one hour, next washed thoroughly with distilled water and scrubbed with a tooth brush before being stored in a pH 7 media for 23 hours. This simulated clinical application of fluoride in patients with normal saliva.

### Analysis of Samples

At the end of the experiment, all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven to determine whether the topical application of fluoride and/or different pH of the saliva had an effect on the autoglazed and/or porcelain surface. The porcelain samples were quantitatively compared.

### The quantitative analysis was conducted as follows

All samples were weighed using the "Sartorius Balance". The weight differences between pre- and post- immersion were calculated in order to determine and compare the amount of porcelain loss from the samples.

Sartorius balance is an electric-automatic pre-weight; model. This kind of balance is very sensitive to small objects and small amounts of material. It weighs from 0 to 200 grams with four decimal numbers. It is being used in the Department of Pharmacology, the School of Pharmacy, University of Pittsburgh, for weighing small amounts of chemical compounds and liquids.

### Results

At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance". The weight differences between pre- and post- immersion were calculated and statistically analyzed. The statistical test used was a two-way analysis of co-variance and is summarized in table 3.

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### Finding of Group I

Five samples autoglazed and five overglazed were washed thoroughly in distilled water, dried in a vacuum oven for 48 hours, weighed and immersed in pH 5 media for 25 days (the length of the study). At the end of the study all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance". The weight difference between pre- and post- immersion were calculated and are shown in table AI and Group I and table BI Group I, the overglazed samples and autoglazed samples released a very small portion of porcelain.

For the autoglazed samples, the mean difference between the pre- and post- treatment weight was 0.0011, while for the overglazed sample the mean difference between the pre- and post- treatment was .0012, which were found to be statistically not significant.

Group I Autoglazed Samples Immersed in pH5 for 25 days			
(AI)			
Sample #	WT #0	WT #1	WT #0-WT #7
A6	2.015	2.0123	0.0027
A7	1.881	1.8807	0.0001
A9	2.114	2.1143	0.0000
A10	1.806	1.8050	0.0015
A20	1.906	1.9064	0.0000
Mean	1.944	1.9437	0.0011

Statistically not Significant.

Source of Variation	Sum. Of Squares	Degrees of Freedom	Mean Square	F*	Tail Prob.	Regression Coefficients
GLAZ	0.00000	1	0.00000	1.22	0.6430	
pH	0.00001	1	0.00001	1.65	0.2054	
F	0.00001	2	0.00000	0.41	0.6639	
GP	0.00002	1	0.00002	2.60	0.1134	
GF	0.00002	2	0.00001	1.47	0.2392	
PF	0.00003	2	0.00001	1.76	0.1832	
GPF	0.00001	2	0.00000	0.37	0.6947	
1 -ST COVAR	0.78721	1	0.78721	109706.75	0.0000	0.99941
Error	0.00034	47	0.00001			

Table 3: Summary of Analysis of Variance.

\* Not Significant

Overglazed Samples Immersed in pH5 for 25 Days			
B I			
Sample #	WT #0	WT #1	WT #0-WT #7
B1	1.9943	1.9935	0.0008
B11	2.0236	2.0221	0.0015
B14	2.0892	2.0873	0.0019
B16	2.1173	2.1163	0.0010
B19	2.1358	2.1349	0.0009
Mean	2.0720	2.0708	0.0012

Statistically not Significant.

### Finding of Group II

Five samples auto glazed and five overglazed were washed thoroughly in distilled water, dried in a vacuum oven for 48 hours, weighed and immersed in ph. 7 media for 25 days (the length of the study). At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance". The weight difference between the pre and post immersion was calculated and are shown in table AII Group II and table B II Group II. There is no difference between pre- and post- measures.

For the auto glazed samples, the mean difference between the pre- and post- treatment weight was .0002" while for the overglazed samples the mean difference between the pre- and post-treatment was .000 which were found to be statistically not significant.

GROUP II Autoglazed Samples Immersed in pH7 for 25 days			
(A II)			
Sample #	WT #0	WT #1	#0-1
A5	1.9783	1.9783	0.0000
A8	2.0782	2.0782	0.0000
Al5	1.8785	1.8777	0.0008
Al8	1.9918	1.9918	0.0000
Al9	2.0158	1.9957	0.0001
Mean	1.9885	1.9843	0.0002

Statically not Significant.

### Finding of Group III

Five samples autoglazed and five over glazed were washed thoroughly in distilled water, dried in a vacuum oven for 48 hours,

Overglazed Samples Immersed in pH7 for 25 Days			
(B 11)			
Sample #	WT #0	WT #1	#0-1
B2	1.8306	1.8306	0.0000
B4	2.0578	2.0578	0.0000
B8	1.8744	1.8744	0.0000
B15	2.1200	2.1200	0.0000
B17	1.8860	1.8860	0.0000
Mean	1.97376	1.97376	0.0000

Statistically not significant.

weighed and immersed in 0.5% acidulated phosphate fluoride for one hour and washed in distilled water and scrubbed with a tooth brush, then stored in a pH 5 media for 23 hours.

This procedure has been repeated for 25 days. At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance".

The weight difference between the pre- and post- immersion were calculated and are shown in table A III Group III and table B III Group III showed the overglazed samples released more porcelain than autoglazed samples.

Group III for the autoglazed samples, the mean difference between the pre- and post- treatment weight was, .0017, and for the overglazed samples the mean difference between the pre and post treatment weight was 0.0031, which were found to be statistically not significant.

Group III Autoglazed Samples are Immersed in 0.5%APF* and pH5 for 25 Days			
(A III)			
Sample #	WT #0	WT #1	#0-1
Al	1.7854	1.7836	0.0018
A3	2.0666	2.0656	0.0010
A12	1.9600	1.9585	0.0015
Al3	1.9590	1.9572	0.0018
Al6	1.9238	1.8212	0.0026
Mean	1.9189	1.9172	0.0017

Statistically not significant.

Overglazed Samples are Immersed in 0.5%APF* and pH5 for 25 Days			
(B III)			
Sample #	WT #0	WT #1	#0-1
B3	1.19780	1.9726	0.0054
B5	2.0113	2.0092	0.0021
B6	1.9171	1.9132	0.0039
B9	1.7696	1.7672	0.0024
B10	1.9659	1.9643	0.0016
B21	1.9949	1.9919	0.0030
Mean	1.92838	1.92530	0.0031

Statistically not significant.

APF = Acidulated Phosphate Fluoride.

### Finding of Group IV

Five samples auto glazed and five overglazed were washed thoroughly in distilled water, dried in a vacuum oven for 48 hours, weighed and immersed in 0.4% stannous fluoride, for one hour and washed in distilled water and scrubbed with a tooth brush and stored in pH 5 media for 23 hours. This procedure has been repeated for 25 days. At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance". The weight difference between the pre and post immersion was calculated and are shown in table A IV Group IV and table B IV Group IV. There is a very minimum difference to no difference.

For the autoglazed samples, the mean difference between the pre- and post- treatment weight was .0011 for the over glazed samples, and the mean difference between this pre- and post- treatment weight was, .0021, which were found to be statistically not significant.

Group IV Autoglazed Samples Immersed in 0.4% (stannous fluoride) and pH5 for 25 days			
(A IV)			
Sample #	WT #0	WT #1	#0-1
A2	2.0552	2.0540	0.0012
A4	2.1320	2.1313	0.0007
All	2.0149	2.0130	0.0019
Al4	1.8027	1.8013	0.0014
Al7	1.9971	1.9966	0.0005
Mean	2.00038	1.99924	0.0011

Statistically not significant.

Overglazed Samples Immersed in 0.4% (Stannous Fluoride) and pH5 for 25 Days			
(B IV)			
Sample #	WT #0	WT #1	#0-1
B7	1.8528	1.8510	0.0018
B12	1.6154	1.6137	0.0017
B13	1.9236	1.9214	0.0022
B18	1.9733	1.9711	0.0022
B20	1.9897	1.9867	0.0030
Mean	1.87096	1.86878	0.0021

Statistically not significant.

### Finding of Group V

Five samples autoglazed and five samples overglazed were washed thoroughly in a distilled water, dried in a vacuum oven for 48 hours, and immersed in 0.5% acidulated phosphate fluoride for one-hour and washed in distilled water and scrubbed with a tooth brush then stored in a pH 7 media for 23 hours.

This procedure has been repeated for 25 days. At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance".

The weight difference between the pre and post immersion were calculated and are shown in table A V Group V and table B V Group V. The difference was very minimum to no difference.

For the autoglazed sample the mean difference between the pre- and post- treatment weight was-.00015, while for the over-glazed samples the mean difference between the pre- and post-treatment weight was .00014 which were found to be statistically not significant.

Group V Autoglazed Samples Immersed in 0.5% APF* and pH7 for 25 Days			
(A V)			
Sample #	WT #0	WT #1	WT #0-WT #1
A22	2.0856	2.0851	0.0005
A23	1.9296	1.9296	0.0000
A24	2.1168	2.1162	0.0006
A28	2.0321	2.0320	0.0001
A30	1.7314	1.7314	0.0000
Mean	1.9791	1.9789	0.00015

Statistically not significant.



Overglazed Samples Immersed in 0.5% APF* and pH7 for 25 Days			
(B V)			
Sample #	WT #0	WT #1	WT #0-WT #1
B24	1.9476	1.9476	0.0000
B27	2.2065	2.2058	0.0007
B28	2.3222	2.3222	0.0000
B29	2.4368	2.4368	0.0000
B30	2.5091	2.5091	0.0000
Mean	2.28434	2.2843	0.00014

Statistically not significant.

\*APF = Acidulated Phosphate Fluoride

### Finding of Group VI

Five samples autoglazed and five samples overglazed were washed thoroughly in distilled water, dried in a vacuum oven for 48 hours, and immersed in 0.4% stannous fluoride for one hour and washed in distilled water and scrubbed with a tooth brush, then stored in pH 7 for 23 hours.

This procedure has been repeated for 25 days. At the end of the experiment all samples were washed thoroughly in distilled water and dried for 48 hours in a vacuum oven. All samples were weighed using the "Sartorius Balance".

The weight difference between the pre and post immersion were calculated and are shown in table A VI Group VI and table B VI Group VI. The difference is very minimum to no difference.

For the autoglazed samples, the mean difference between the pre- and post- treatment weight was .0001 while for the overglazed sample the mean difference between the pre- and post-treatment weight was 0.0001" which were found to be statistically not significant.

Group VI Autoglazed Samples Immersed in 0.4% (Stannous Fluoride) and pH7 for 25 Days			
(A VI)			
Sample #	WT #0	WT #1	WT #0-WT #7
A21	2.0818	2.0818	0.0000
A25	1.8134	1.8134	0.0000
A26	2.0056	2.0052	0.0004
A27	2.1277	2.1276	0.0001
A29	2.1563	2.1563	0.0000
Mean	2.03696	2.03686	0.0001

Statistically not significant.

Overglazed Samples Immersed in 0.4%V (Stannous Fluoride) and pH7 for 25 Days			
(B VI)			
Sample #	WT #0	WT #1	WT #0-WT #7
B21	2.2893	2.2893	0.0
B22	2.1490	2.1490	0.0000
B23	2.2290	2.2290	0.0000
B26	2.2796	2.2793	0.0003
B26	2.3843	2.3843	0.0000
Mean	2.2663	2.2662	0.0001

Statistically not significant.

### Discussion

In the irradiated patients, the oral environment drastically changes. There is an increase in oral flora, acidic pH, and reduced salivary secretion, resulting in increased caries incidence. In the majority of these patient's full coverage by porcelain-fused to metal restoration is the treatment of choice. As a result of continued research to minimize the caries incidence in these patients, a daily fluoride application was recommended by some investigators [2]. The effectiveness of topical application of sodium fluoride in preventing caries incidence has been documented by Guets and Buonocore [3], Rock [4], Louma., et al [5], Horowitz., et al. [6], and Going., et al [1].

The topical use of sodium fluoride has been shown to be an effective measure in reducing dental caries, Bibby [8], Knutson and Armstrong [9]. The effectiveness of sodium fluoride in dentifrices, mouthwashes and by self-application has been documented by Koch [10], and Englander., et al [11].

Fluoride containing varnishes have been shown to increase fluoride content of enamel [12-14]. On the other hand, clinically it was observed that there is an etching effect of some of these fluoride gels on the porcelain surface [15], and by scanning electromicroscope of Al-Dowaisan [16].

The present investigation was conducted to evaluate the effect of APF 0.5% from 1.1% sodium fluoride and 0.4% of stannous fluoride and different pH of the saliva on autoglazed and overglazed porcelain samples in a controlled environment.

Although the results of the present investigation showed no significant weight difference among the various samples which were treated with two types of fluorides and were immersed in two acidic media with different concentrations, one must consider two observations regarding this study. First, the quantitative assessment,

using weight for determining differences, has been shown to be of little value. It seems that the deterioration and loss of porcelain is not necessarily measurable due to the fact that the total weight of the porcelain alone was approximately 0.5 grams while the approximate total weight of the sample was 2.0 grams (porcelain plus metal). Thus, weight differences due to the effect of acidic medium and/or fluoride compounds could be viewed as significant differences, if only porcelain weights were compared.

Second, if the time period used for immersion was increased, one might observe more measurable loss of porcelain weight as compared to the observed weight loss in the present study.

Based on the previous explanations, one might view the results as showing some effect when comparing the use of fluoride associated with pH 5 and pH 7 media.

When comparing the SEM findings by Al-Dowaisan with the findings of present-day investigators, similar results can be found. The current study of samples that were immersed in pH 7 media showed no effect on the porcelain surfaces.

Similarly, the control group of Al-Dowaisan's study used pH 7 media and showed no effect on the porcelain surfaces. The use of acidulated phosphate fluoride in the present investigation and Al-Dowaisan's study showed breakdown and an etching effect on the porcelain surfaces. The use of stannous fluoride in both investigations showed a slight to no effect on the porcelain surface. Based on the results obtained from the comparison between these two investigations, the following correlations can be made:

1. Both studies agreed that the use of acidulated phosphate fluoride demonstrated an etching effect and breakdown on the glazed and unglazed as well as glazed and overglazed surfaces of porcelain.
2. Both studies agreed that the use of stannous fluorides demonstrated minimum to no effect on the glazed and unglazed, as well as glazed and overglazed porcelain surfaces.

The lack of dental literature concerning the effects of fluorides on porcelain surfaces makes this discussion limited in regard to support of the findings of the present study which should be evaluated against the conditions presented. The results of this study showed that acidulated phosphate fluoride associated with pH 5 media enhanced the unfavourable release of porcelain from the

samples. This factor could make the use of acidulated phosphate fluoride in patients with saliva pH 5 unsatisfactory. Unless the acidity of the saliva is reduced or neutralized to avoid the effect of acidulated phosphate fluoride associated with high acidic saliva on the porcelain restorations.

Engelmeier, *et al* [17], stated that Berggren <sup>e7</sup>, a saliva substitute, has proven to be the best salivary substitute thus far. Saliva substitutes can be used full strength or diluted with water to lubricate the oral tissues on an as needed basis. In addition, based on the present results with the Al-Dowaisan results, one could conclude that it is the acidic medium rather than the fluoride compound that has a deleterious effect on porcelain restoration. Accordingly, reduced acidic medium is an important factor in the selection of fluoride compounds for use when porcelain restorations are present.

## Conclusions

Based on the results obtained from this quantitative study, the following conclusions are made:

1. The pH 7 media which simulates the normal saliva showed no effect on the porcelain fused to metal. This means that there was no difference between pre and post immersion weights.
2. The pH5 media which simulates the acidic saliva of patients receiving radiotherapy showed a slight effect on the porcelain-fused-to-metal samples. This means there was a difference between pre and post immersion weights. However, the difference was not significant from a statistical point-of-view and it does seem that there is a chance of a difference.
3. The use of acidulated phosphate fluoride associated with acidic media pH 5 has more effect on the porcelain samples. This means that there was a difference between pre and post immersion weights and these differences were the greatest compared to the other groups.
4. The use of stannous fluoride associated with pH 5 media has shown minimum to no effect on porcelain fused-to-metal samples.
5. The use of stannous fluoride associated with pH 7 and the use of acidulated phosphate fluoride associated with pH 7 media has shown very minimum effects to no effect on the porcelain fused-to-metal samples.
6. Additional research is needed to study the effect of different fluorides prepared at different concentrations and at different pH levels of the saliva on different types of porcelain fused to metal.

<sup>7</sup>\*Xerolube: (Scherer Laboratories, Inc., Dallas, TX.)



7. Although the results of this study were statistically not significant, longer immersion periods may show significant deviation.
8. This study suggests further studies to obtain a special regimen to save and protect the aesthetic of patients who have a number of porcelain teeth restorations and undergoing fluoride treatment. Either by using protective materials or by using saliva substitutes to reduce or neutralize the acidity of the saliva of patients with high acidic saliva.

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