Original Article

DOI: 10.7860/JCDR/2015/14377.6505

Dentistry Section

Spectrophotometric Study of the Effect of Luting Agents on the Resultant Shade of Ceramic Veneers: An Invitro Study

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ABSTRACT

Introduction: Dentistry has found practically the best available aesthetic answer, is ceramic restoration. There are various factors that contribute to the success of ceramic veneers, like colour of underlying tooth, thickness if ceramics and the type of underlying luting cement. Shade selection and matching remains still challenge, however the shade of luting agent used for cementation of veneers produces a change in resultant shade of veneers.

Aim: To compare and analyze the spectrophotometric effect of opaque and transparent luting agent on resultant shade of ceramic veneers made of 2L1.5 shade (Vitapan 3D-Masters) and B2 shade (Vitapan Classic).

Materials and Methods: Out of 15 ceramic veneers of 2L1.5 shade (VITAPAN 3D- Master), seven teeth cemented with opaque cement and eight teeth with transparent cement shade of dual cure resin cement (Variolink II™). Out of 10 ceramic veneers of B2 shade (VITAPAN Classic), five teeth were cemented with opaque cement and other five teeth with transparent cement shade of dual cure resin cement (Variolink II™). Spectrophotometric (Macbeth U.S.A.) analysis of all ceramic veneer crowns done with optiview software and readings were recorded in Commission Internationale de l' Eclairge {CIELAB} system and dE value was calculated.

Statistical Analysis: Statistical analysis was done by using Paired t-test.

Results: Spectrophotometric analysis of all the veneers cemented with opaque luting agent were lighter in shade due to significant change in dL value. Veneers cemented with transparent luting agent were darker in shade due to significant change in the dL value.

Conclusion: Opaque luting agent gives lighter shade and transparent luting agent gives darker shade to ceramic veneers fabricated with 2L1.5 and B2 shades.

Keywords: Aesthetic dentistry, Discolouration, Restoration, Spectrophotometer

INTRODUCTION

At present, it's a demanding task for the dental practioners and ceramists to get first-rate results, especially with the ceramic veneers [1,2]. For the restoration of traumatized, fractured and worn dentition, abnormal anatomy or malpositioned teeth, ceramic veneers (CVs) are frequently indicated; on the other hand CVs can also be specified for the teeth with moderate discolouration caused by tetracycline, fluoride, aging and amelogenesis imperfecta [2].

The essence of naturalness is very unpredictable and not in confirmation with any established standard. This has been probably the biggest stumbling block in the dental profession's age, long quest to achieve natural replica of a tooth, which is practically indistinguishable. In recent years, new bonding techniques and materials have been introduced that have improved the bond strength of ceramic veneers to dentin with strengths that are close to the bond to enamel [3-5]. Aesthetic dentistry today has found practically the best available answer, is the ceramic veneer.

The veneers are expected not only to mask the discolouration of the underlying tooth structure but also to give a life like appearance [6-9]. The challenging aspect of treatment with ceramic veneers is to achieve maximum aesthetics, which includes the colour change with minimal loss of enamel. There are various factors, which contribute to the success of ceramic veneers such as colour of underlying tooth, thickness of ceramic veneers, the type of underlying resin cement [10].

The predicament of shade selection and shade matching of the veneer still ruins the main clinical challenge that it is further compounded and complicated by the shade of the luting agent, while cementation of the veneer also produces a change in the resultant shade of the veneers. Hence, an attempt was made to study the effect of luting agents, such as opaque and transparent, on the resultant shade of ceramic veneers of 2L 1.5 shade (Vita pan 3D-Master) and B2 shade (Vita pan Classic) fabricated on extracted human teeth using a spectrophotometer.

MATERIALS AND METHODS

The present study was conducted in the Department of Prosthodontics, Government Dental college and Hospital, Mumbai. Maharashtra, India, from the year 2000 to 2001.

Collection of Extracted Teeth

Before starting the study, premeditated the few articles and took the opinion of statistician for the sample size and decided the sample size for the present study.

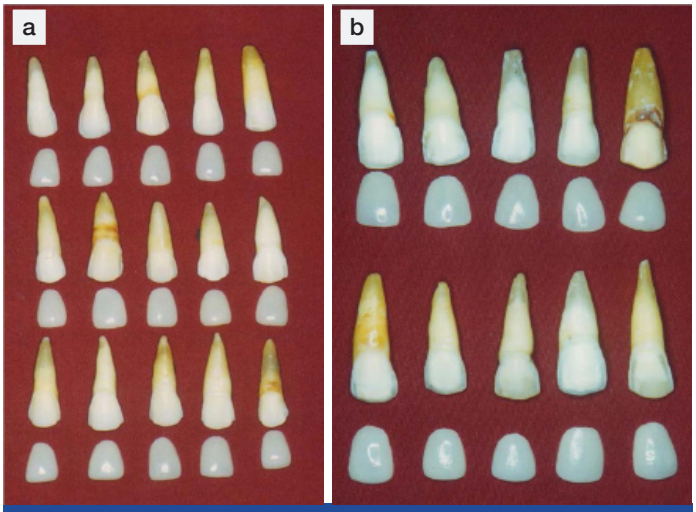
Fabrication of ceramic veneers: Twenty five extracted human maxillary Central incisor teeth were collected from the Deparment of Oral and Maxillofacial Surgery, Government Dental College and Hospital, Mumbai. Teeth with the normal crown anatomy, similar in size and shape as far as possible and irrespective of age, sex or side were included and the teeth with dental caries and restorations were excluded from the present study.

Selected teeth were divided into group A (15) for ceramic veneers prepared with VITAPAN 3D Master 2L1.5 shade and group B (10) for VITAPAN Classic B2 shade. Then teeth were cleaned with water to remove the gross debris and stored in normal saline water at room temperature from the day of extraction until the testing.

Preparation of Teeth for Ceramic Veneers [2]

Tooth preparation started from the facial surface as two planes, cervical two third and incisal one third of the tooth. With the help of depth cutting bur three horizontal surface depth cuts were made, later half of the facial surface reduced up to 0.5 mm uniformly with the help of chamfer end bur. Half of the unreduced facial surface taken as control group [2].

A chamfer finish line was prepared just above the cement-enamel junction by keeping the proximal finishing line labial to proximal contact area of the tooth. Facio-incisal surface of the tooth reduced upto 0.5 mm. Bevel was placed of 0.2 mm over the labial surface. No incisal reduction was done [Table/Fig-1a&b].



[Table/Fig-1a/b]: (a) Clinical picture of the 15 prepared teeth samples for ceramic veneers. **(b)** Clinical picture of the 10 prepared teeth samples for ceramic veneers

Impression of Prepared Teeth and Making Master Die

Impression of an individual tooth made in two steps (putty/wash) using stock tray, was inspected for evidence of any wear and tear. Then the impression was poured in die stone (Ultrarock) and master dies were prepared. Duplication of master die was done with VITA –Hi-cream. Refractory die was fabricated by VITADURVEST MATERIAL (fine grained graphite free). Die was hardened at 600^{0}C for 10 min and temperature increased up to 1050^{0}C for five min then cooled to room temperature. Once the firing of refractory die completed up to the temperature of 1000^{0}C, the die was sealed with Vita akzent glaze

Porcelain Build Up

Fabrication of putty index was made with polyvinylsiloxane (3M express) putty impression material. Application of porcelain by layering technique and build up was done with proper condensation method. Fifteen ceramic veneers of 0.5 mm thickness were fabricated with shade selected from VITAPAN 3D-Master; 2L1.5 commonest shade for Indians was selected for dentine and for Enamel EN2 enamel powder was used for group A. Ten ceramic veneers fabricated with B2 shade selected from VITAPAN Classic, dentin (B2) and enamel (EN1) powder was used for group B. Refractory die material was removed with round bur No 8, taking care not to damage the veneers, then veneers were tried on prepared tooth for margin accuracy and fit.

Cementation of Ceramic Veneers

The authors personally met a few selected dental practitioners in Mumbai, who were asked seven questions regarding the shade of dual core resin cement and inquired about their opinion. Analysis was done based on their opinion (questionnaires survey) it was found that most of the practitioners used Variolink II (Ivoclar) which is easily available, economical and available in different shades.

In group A, teeth were divided into two groups, seven teeth were cemented with opaque cement and eight teeth were cemented with transparent cement shade of dual core resin cement (Variolink II ™). In group B, 10 teeth were divided into two groups, five teeth were cemented with opaque cement and five teeth with transparent cement (Variolonk II ™) [Table/Fig-2,3].

[Table/Fig-2]: Upper row: 2L1.5 shade (VITAPAN 3-D Masters) veneers cemented with opaque luting agent. Lower row: 2L1.5 shade (VITAPAN 3-D Masters) veneers cemented with transparent luting agent

[Table/Fig-3]: Upper row: B2 shade (VITAPAN Classic) veneers cemented with opaque luting agent. Lower row: B2 shade (VITAPAN Classic) veneers cemented with transparent luting agent

Spectrophotometric Analysis

To ensure that the spectrophotometer evaluated the same area of the tooth every time, 'positioning guide' was fabricated from self cure acrylic resin. Positioning guide was filled with microcrystalline wax in which tooth was embedded. Three markings were placed on either side of the tooth and one in the center of tooth as shown in [Table/Fig-4].

Once the subjects (teeth) were ready for spectrophotometric analysis, individual teeth were tested at middle third of the labial surface, because the translucency of the incisal edge makes the colour dependent on the background whereas the cervical measurement reflects inordinate pink colour of the gingival tissue. Analysis was carried out by means of spectrolino Spectrophotometer from Macbeth U.S.A, with dual reflectance spectrophotometer and 45^0/0^0 geometry (45^0 illumination, 0^0 viewing) was utilized to view samples much the same way that human observer would do in a shade of #natural tooth [11] and aperture of 2.5 mm diameter. Geometry reflectance spectrophotometer emits a beam of light, strikes over middle third of the labial surface of each tooth sample and is then reflected to the diffraction grating monochromatic, which disperses the reflected light to silicone photodiode detector. Information is converted into processable data and sent to a computer (Optiview software).

Spectrophotometric measurement of the samples were recorded in terms of L*, a*, b* co-ordinate with CIELAB colour space.

Twenty five sample were tested and the readings were recorded

1. After preparation with ceramic veneer but with glycerin gel without luting (Opaque or transparent) agent i.e. before cementation.
2. After cementation with luting (Opaque or transparent) agent.

[Table/Fig-4]: Sample position for Spectrophotometric analysis

Readings were recorded in CIELAB (Commission International de l' Eclairge) System. CE L* a* b* gives numerical representation of 3D measure of colour.

L* describes lightness of the object being assessed,

a*determines the colour on red-green axis, where as b* on yellow-blue axis.

dE (delta) value (total colour change) was determined by formula given below

$dE = \sqrt{(dL^*)_2 + (db^*)_2 + (da^*)^2}$

dL* is the difference of L*,

da* is difference of a* and b* is the difference of b*.

Values obtained for L* a* b* and dE were subjected to statistical analysis.

STATISTICAL ANALYSIS

Study protocol was approved by the Institutional Ethical Committee. All the study subjects enrolled in the study only after they had provided informed written consent. All the calculations were performed using Microsoft office 2010 version for windows. Statistical analysis was done by using paired student t-test.

RESULTS

Colour of each veneer was compared between before and after cementation to calculate the overall change in colour (dE). The same procedure was carried out for veneers fabricated with 2L1.5 and B2 Shade and half the samples of each group were cemented with opaque and other half samples of each group were cemented with transparent luting agent.

When veneers were cemented with opaque luting agent the resultant change in colour (dE) was less. Resultant changes in colour of veneer of 2L1.5 shade were in the range of (1-3) and B2 shade veneers showed colour changes that were in the range of (2-3). The change in colour was significant due to change in value (dL). For 2L1.5 shade veneers, which were cemented with opaque luting agent, the change in value (dL), was in the range of (1-3) and for B2 shade veneers, change in value (dL) was in the range of (1-2). The resultant cemented veneers were lighter in shade.

The change in da* (red-green axis) for both 2L1.5 shade and B2 shade veneers was in the range of (0.365 to 0.601) and (-1.188 to 0.245) respectively. The change was statistically insignificant. The change in db* (yellow-blue axis) for both 2L1.5 shade and B2 shade veneers was in the range of (-2.002 to 1.756) and (-2.846 to -0.537) respectively. The change was insignificant. Thus all the veneers cemented with opaque luting agent were lighter in shade due to significant change in value dL [Table/Fig-5,6].

When veneers were cemented with transparent luting agent, the resultant change in colour was more. Resultant changes in colour (dE) of veneer B2 shade were in range of (2-5) and 2L1.5 shade colour change (dE) in the range of value (dL) in range of (3-5). For 2L1.5 shade veneer, which were cemented with transparent luting agent, the change in value (dL), was in a range of (-2.2 to -5.4) and B2 shade

Pre/Post Cementation				
Sr. No.	dL*	da*	db*	dE*
1	1.104	0.601	0.455	1.337
2	2.403	0.301	1.756	3.002
3	3.119	-0.142	0.367	3.096
4	1.253	0.183	0.007	1.266
5	2.708	0.599	-1.193	3.109
6	2.547	0.365	-2.002	3.260
7	3.001	0.591	-1.150	2.954
Range	1.104 ↓ 3.119	0.365 ↓ 0.601	-2.002 ↓ 1.756	1.266 ↓ 3.109

[Table/Fig-5]: Pre/Post Cementation Change in (L*a*b*) for Veneer fabricated with 2L1.5 Shade (Vitapan 3 D Master) Using Opaque luting agent

Pre/Post Cementation				
Sr. No.	dL*	da*	db*	dE*
1	2.559	-1.188	-2.004	3.460
2	1.151	0.151	-2.999	3.216
3	1.922	0.245	-0.537	2.011
4	2.405	0.156	-1.434	2.804
5	2.326	0.238	-2.846	3.683
Range	1.151 ↓ 2.559	-1.188 ↓ 0.245	-2.846 ↓ -0.537	2.011 ↓ 3.683

[Table/Fig-6]: Pre/Post Cementation Change in (L*a*b*) for Veneer fabricated with B2 Shade (Vitapan Classic) using Opaque luting agent

Pre/Post Cementation				
Sr. No.	dL*	da*	db*	dE*
1	-3.645	0.768	0.837	3.818
2	-2.263	0.051	0.806	2.403
3	-4.641	-0.624	-1.769	5.005
4	-5.258	-0.618	-0.732	5.345
5	-5.491	-0.484	-1.607	5.742
6	-4.566	-0.736	-2.207	5.124
7	-3.941	-0.321	0.422	3.976
8	-3.655	-0.190	0.959	3.783
Range	-2.263 ↓ -5.491	-0.736 ↓ 0.768	-2.207 ↓ 0.422	2.403 ↓ 5.742

[Table/Fig-7]: Pre/Post Cementation Change in (L*a*b*) for Veneer fabricated with 2L1.5 Shade (Vitapan 3D Master) using Transparent luting agent

Pre/Post Cementation				
Sr. No.	dL*	da*	db*	dE*
1	-4.255	0.175	0.186	4.263
2	-4.019	0.384	0.373	4.054
3	-5.582	0.257	0.213	5.633
4	-2.277	0.514	0.121	3.154
5	-5.359	-0.227	0.775	5.420
Range	-5.582 ↓ -2.277	-0.227 ↓ 0.514	0.121 ↓ 0.775	3.154 ↓ 5.633

[Table/Fig-8]: Pre/Post Cementation Change in (L*a*b*) for Veneer fabricated with B2 Shade (Vitapan Classic) using transparent luting agent

veneer change in value (dL), was in a range of (-5.5 to -2.2) [Table/Fig-7,8].

The change in da* (red - green axis) for both 2L1.5 shade and B2 shade veneer change in value (dL), was in a range of (-5.5 to -2.2). The change in da* (red-green axis) for both 2L1.5 shade and b2 shade veneers were in the range of (-0.736 to 0.768) and (-0.227 to 0.514) respectively. The change was insignificant [Table/Fig-7,8].

The change in db* (yellow-blue axis) for both 2L1.5 shade and b2 shade veneers were in the range of (-2.207 to 0.422) and (0.121 to 0.775) respectively. The change was insignificant. All the veneers cemented with transparent luting agent were darker in shade due to significant change in value i.e. dL [Table/Fig-7,8].

DISCUSSION

The dental profession has long been hampered with the shade matching problem of ceramic restoration with the patient's natural dentition. Various investigations have been performed by a number of researchers to find a solution to this perplexing issue. Inadequate technology to aid the dentist and ceramist in the appropriate selection of shade has rendered this part of dentistry and art rather than a science [5,12,13].

Teeth with moderate discolouration, for restoration of traumatized, fractured, worn dentition and also to correct abnormal anatomy or mal-positioning of the teeth, ceramic veneers are commonly indicated [3,5,14]. Due to the rapid development in material science, techniques and the need for aesthetics, ceramic veneers are now evolving as a more functional, aesthetic and dynamic restoration [15-18].

Although numerous studies have been reported on the spectrophotometric analysis of porcelain fused to metal restorations, little research is available on the final shade determination of the ceramic veneers. Mc Claughin did a subjective visual evaluation of veneers of different thickness and concluded that porcelain opacity did have an effect on the final appearance of the ceramic veneers [19]. Davis and Johnson studied the effect diluting laminate porcelain with body and modified porcelain and they found that addition of modified porcelain affect the final colour [20]. Crispin and Hewlett studied the correlation of try – in paste with resin cement shade on the resultant shade of ceramic veneers. They concluded that try-in paste does not exactly match their corresponding cement colour and their differences are extremely variable [21]. Extremely little literature review is available regarding the study being done on the effect of luting agents on the final shade of ceramic veneers, which have been fabricated on extracted human teeth, for that reason an attempt was done in the present study.

Various shade guides for ceramic veneers are available in the Indian market. VITA shade guide was introduced in 1968 and has gained universal acceptance. The newer system VITAPAN 3D- Master has shade tabs, which are more logically and systematically arranged in the colour space. A survey carried out has revealed that the most common shade of Indian Population as determined by VITAPAN 3D-Master and VITAPAN classic shade guide is 2L1.5 and B2 respectively. Thus the VITAPAN 3D- Master and VITAPAN Classic shade guide were selected for the study.

In Group A, Veneer fabricated with 2L.5 (VITAPAN 3D MASTER) was compared before and after cementation with opaque and transparent shade luting agents. Similarly, in Group B veneers fabricated with B2 (VITAPAN classic) were compared before and after cementation with opaque and transparent shade luting agents. Cubas GBA et al., reported that the resultant shade of porcelain veneers is independent of types of luting agent used [22].

According to the literature, when dE value>1 difference is perceptible. When dE value between 1and 2 considered good colour match and dE values were between 2 and 3.7 its clinically acceptable in oral environment however, De value >3.7 it's considered as poor match [21].

Veneers cemented with opaque luting agent showed change in dE due to increase in value (L*). The resultant cemented veneers were lighter in shade, due to its masking efficiency, masks the effect of underlying tooth structure and increases the value (L*) of the cemented veneer.

Resultant change in colour dE of ceramic veneer after cementation with transparent cement is higher due to the effect of underlying colour of the tooth structure and decrease in the (L*) value.

The changes in the resultant colour of the ceramic veneers were due to significant change in (L*) value of 2L1.5 shade {(-2) to (-5)} and B2 {(-2)to (-5)}.

The ceramic veneers fabricated bilaterally are easier to match than a single ceramic veneer. However, the matching for a single tooth ceramic veneer with the natural adjacent tooth becomes difficult due to numerous factors [23]. The above mentioned result clearly depicts the crucial role of the shade of the luting agents in the resultant shade of the ceramic veneers. But, the expertise of the clinicians in mixing these shades should not be over looked, as it is crux of matching single veneer to the adjacent natural teeth. Even Suputtamongkol K et al., found no change in the shade of on zirconia based ceramic veneers [24].

Study indicates that luting agents play a significant role in the final shade of the ceramic veneers. Use of the transparent shade of the luting agent actually produces greater change in the resultant shade of the ceramic veneer as compared with the opaque luting agents.

LIMITATION

Limitation of our study would be relatively smaller sample size included. Further studies with larger sample size including different ceramic veneers are warranted.

CONCLUSION

All ceramic veneers fabricated with 2L1.5 shade (VITAPAN 3D - MASTER) and B2 shade (VITAPAN CLASSIC); cemented with opaque and transparent luting agents, showed change in the resultant colour of the veneers. When opaque dual cure resin (Variolink II™) was used as a luting agent, the resultant change in colour dE was less. The veneers were lighter in shade due to an increase in (L*) value. They were less yellow and no significant change in redness as compared to the pre-cemented sample was observed.

However, as transparent (dual cure resin (Variolink II™) was used as a luting agent, the resultant change in colour dE was greater, veneers were darker in shade due to a decrease in (L*) value. They were more yellow and no significant change in redness as compared to the pre -cemented sample was observed.

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FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **Apr 07, 2015**
Date of Peer Review: **Jun 04, 2015**
Date of Acceptance: **Jul 20, 2015**
Date of Publishing: **Sep 01, 2015**