An In-Vitro Study on Effect of Multiple Firings on Color of Metal Ceramic Restorations

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Abstract: ***Preparation of porcelain restorations that match the natural dentition has been a subject of great concern for many years. An understanding of the process by which the colour and translucency of fixed restorations are planned and obtained so as to replicate the colour of its adjacent teeth is important for achieving an aesthetic restoration. This study was done to study the effect of fabrication procedures such as ceramic thickness and number of firing cycles on the colour of metal ceramic restorations.***

Keywords: Metal- Ceramic Restorations, Firing cycles, color of restoration

1. Introduction

Dental esthetics is intangible, influenced by the wishes of the patient, experience of the clinician and the artistic and technical skills of the ceramist. It lies in the murky twilight between art and science. Art is not enough to create life like restorations, while science alone is inadequate for pleasing results.

In the patient's perception of dental attractiveness one of the most important considerations in judging the finished restoration is the shade of the restoration [1]. Patient satisfaction with shade match and reproduction is important when constructing or replacing a restoration and the subject matter has always been a dilemma even for the most eminent practitioner. Fabricating restorations of shades compatible with those of the adjacent teeth has two aspects to it i.e. shade matching and shade duplication. Despite careful shade selection color of the restoration may be affected by fabrication procedures. Though there is appreciable amount of literature available on matching shade tabs with adjacent teeth [2–6], the dental profession has long been confronted with the problem of replicating the matched color.

Preparation of porcelain restorations that match the natural dentition has been a subject of great concern for many years. An understanding of the process by which the color and translucency of fixed restorations are planned and obtained so as to replicate the color of its adjacent teeth is important for achieving an esthetic restoration. Errors, especially in the color replication process, have been a problem for dentists and technicians and may lead to dissatisfaction of the patient [7].

Visually detectable differences between color of shade tab and fired porcelain are not uncommon. An understanding of the science of color, color perception and replication is crucial for success in the ever expanding field of esthetic restorative dentistry. This investigation aimed at studying the effect of repeated firing cycles on the color of metal ceramic restorations.

2. Materials and Methods

The samples used in this investigation were in the form of flat discs. Each sample had a flat cylindrical metal base, over which porcelain was baked. A total of 10 samples were made which were divided into two groups of five samples each. There were two aspects to the fabrication of samples for color measurement i.e. fabrication of metal discs and firing of porcelain with different number of firing cycles. A ring of 3.5 mm diameter was cut out from a Delrin plastic syringe which served as a mold for fabricating10 discs of equal thickness using inlay wax

Figure 1: Mould for fabricating wax discs).

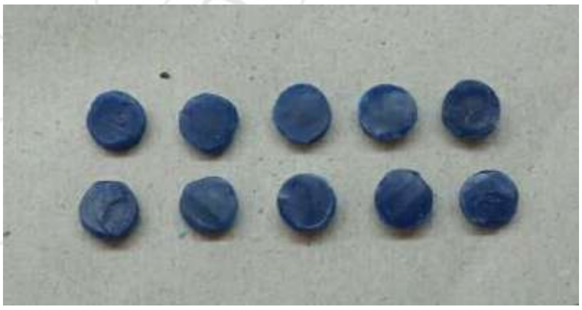

Figure 2: Wax samples fabricated for casting).

All the discs were sprued in a conventional manner and invested in a phosphate bonded investment material (Bellasum, Bego)

Figure 3: Investing wax discs).

Lost wax technique was followed and the samples were cast into nickel chromium discs using a centrifugal casting machine. After casting, discs were devested and sandblasted with 110 micron alumina and were finished and polished in a usual manner.

PORCELAIN BUILD UP

Metal discs thus fabricated were degassed in a furnace at a temperature of 920 degrees Celsius. Wash opaque powder and liquid ([VMK 95, VITA Zahnfabrik, Bad Sackingen, Germany] was measured and a uniform layer was applied on all the samples using a single stroke of brush. Wash opaque hence applied was fired.

Opaque ceramic (A3 shade) [VMK 95, VITA Zahnfabrik, Bad Sackingen, Germany] was also measured and a uniform layer was applied on all the samples using single stroke of a brush. All the samples were fired.

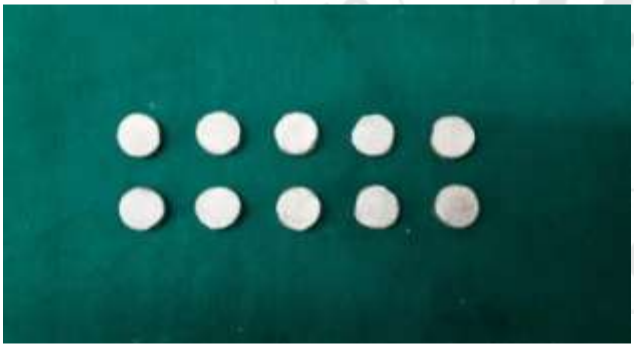

Figure 4: Opaque layer fired

After this stage samples were divided into two groups of 5 samples each to facilitate build-up of dentine ceramic (A3 shade) (VMK 95, VITA Zahnfabrik, Bad Sackingen, Germany) of 1mm thickness:

Group I: 1 mm dentine ceramic thickness for 3 firing cycles
Group II: 1 mm dentine ceramic thickness for 5 firing cycles

DENTINE CERAMIC BUILD UP

Molds were fabricated for the buildup of 1mm ceramic thickness. Dentine slurry was formed with measured amount of dentine ceramic and modeling liquid and condensed into the moulds previously formed to fabricate ten samples.

Digital vernier Caliper was used to precisely adjust the thickness of group all samples to 1mm

Figure 5: Digital vernier caliper used to measure thickness of the samples

Metal discs with dentine build up were carefully taken out from their respective moulds. Dentine hence built up was subjected to a firing cycle up till temperature of 920 C.

Same firing cycle was used for subjecting the samples to multiple firings to observe any change in color with repeated firings.

Figure 6: Dentin build up and fired samples

Color Measurement: Orientation of the Samples for Color Measurement

Orientation indices were made for all the 2 groups of samples to precisely place the samples in the same position every time the color was measured. This ensured recording the same spot on every sample after each firing.

Spectrolino (Gretag MacbethInc., Germany) Spectrophotometer was used to objectively measure the color of all the samples in terms of CIELAB color space. This instrument is capable of simulating the same intensity as that of daylight, D50, for every reading that is taken, thereby eliminating the influence of variable external lighting conditions. A standard observer was selected for the entire study.

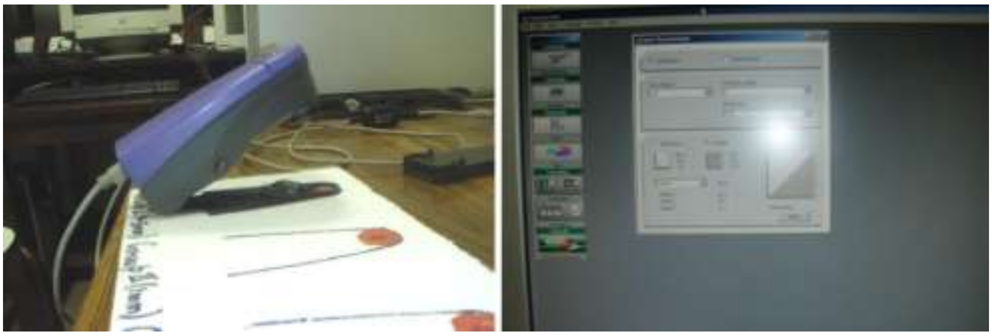

Figure 7: spectrophotometer used for color measurement)

Readings were taken after third cycle for group 1 samples and after fifth cycle firing for group 2 samples. To take care of human error while taking readings, three readings were taken each time and later a mean of these three readings was calculated for statistical evaluation using the 'paired T test.

3. Results

Color of the samples was measured by Spectrolino (Gretag MacbethInc. Germany) Spectrophotometer using CIELAB color space which measures color in terms of L*, a*, b* and DE co-ordinates. Square root of the sum of squares of L*, a* and b* values gives the value for DE.

Tables were formulated for the both groups, representing the change in L*, a*, b* and DE co-ordinates of the five samples of each group with an increase in the number of firing cycles.

Table 1: Color variation of samples after multiple firings

Firings	L*	a*	b*	DE
2	72.78	1.56	12.74	17.23
3(group 1)	73.13	1.4	12.49	16.89
5(group 2)	72.85	1.53	12.69	17.55

Table 2: Comparison of L* variant amongst the 2 groups after multiple firings

Firings	L* Group II
2	72.78
3	73.13
5	72.85

Table 3: Comparison of a* variant amongst the three groups after multiple firings

Firings	a* Group II
2	1.56
3	1.4
5	1.53

Table 4: Comparison of b* variant amongst the three groups after multiple firings

Firings	b* Group II
2	12.74
3	12.49
5	12.69

No significant change was noticed in any of the four color parameters between the baseline reading after third firing and after fifth firing for both the groups.

4. Discussion

Metal ceramic restorations first became commercially available during the late 1950s [8]. Today this technique is considered a routine procedure in dentistry although it may not fulfill the esthetic requirements especially pertaining to color in many patients. Despite the ever increasing additions to the list of dental ceramics with improved mechanical and esthetic properties, dentists often face the difficulty of replicating the color of natural teeth. Many factors such as porcelain brand, amount of tooth reduction, thickness of metal substructure, condensation technique & number of firing cycles might affect the final color of the restoration. Considering the popularity of metal ceramic restorations in dentistry on account of their affordable cost and esthetic potential, this study was carried out to study the effect of two variables i.e. thickness of dentine ceramic and number of firing cycles on the color of porcelain fused to metal restorations.

Clinicians and technicians often avoid repeated firing of ceramo-metal restorations fearing a shift in the color from that matched with the shade tab. This study was aimed at finding a solution to this dilemma by firing the samples uptil ten firing cycles and measuring the color change with increase in the number of firing cycles.

The CIELAB color system is used almost exclusively for color research in dentistry around the world [9]. It was introduced in 1976 and recommended by the international commission on illumination. The CIELAB color scale is an approximately uniform color scale. In a uniform color scale, the differences between points plotted in the color space correspond to visual differences between the colors. The CIELAB color space is organized in a cube form. The L* axis runs from top to bottom. The maximum for L* is100, which represents a perfect reflecting diffuser. The minimum for L* is zero which represents black. The a* and b* axes have no specific numerical limits. Positive a* is red and negative a* is green. Positive b* is yellow and negative b* is blue Four firings of the samples were selected to represent the typical number of firings used technically to make a ceramo-metal restoration (two opaque, one body & one staining & glazing). Subsequently six, eight and ten firings were performed to examine the effect of repeated firings on color stability. No significant change in color was there for any ceramic thickness with multiple firings. Results of the study were in accordance with those of [9] who reported that repeated firings up to nine times did not noticeably effect the color stability of any shade tested DE differences among groups of multiple firings of ceramic were below the perceivable level (DE \ 3). Yap AUJ [10] compared the difference in color matching between human eye assessment and computerized colorimetry. They reported that the human eye could detect shade changes when DE value was greater than three. Hence these results demonstrated that there were visually undetectable color differences with change in dentine ceramic thickness.

5. Summary

Color stability is an important factor to ensure the long term clinical success of metal ceramic restorations. Therefore it is important to minimize the factors that influence the processing of the shade of ceramo-metal restorations. It is the hope and desire of this study to add to the knowledge of factors effecting color pertaining to ceramo-metal restorations and to provide useful guidelines concerning the trends of color shift. Consistently predictable esthetics and longevity is possible if the factors studied are considered in the fabrication of metal ceramic restorations.

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