



## A Clinical Study to Correlate Maxillary Anterior Natural Teeth with that of the Commercially Available Acrylic and Porcelain Shade Guides

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### ABSTRACT

The success of the dental treatment as perceived by our patients is often preferentially evaluated on the appearance of the restoration. Usually visual determination is unreliable and inconsistent, complicated by the inability of the shade guide to cover the entire dental color range and also there is lack of logical order of arrangement of the tabs. Hence a clinical study is planned to perform visual shade selection in standardized conditions to correlate the shades of maxillary anterior natural teeth in adult subjects of Davangere district origin to one acrylic and three porcelain shade guides commercially available in India.

**Keywords:** Color, Shade tabs, Light source.

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### INTRODUCTION

The success of dental treatments as perceived by our patients is often preferentially evaluated on appearance of the restorations. The clinician's understanding of this requirement contributes to a higher success level in satisfying his or her patient's needs.

Color determination in dentistry can be divided into two categories visual and instrumental. From a clinical standpoint human eye remains unsurpassed in its ability to detect subtle nuances of color between two comparable objects. Visual color determination involves comparison of the patient's tooth color with a standard color reference shade guides.<sup>1</sup>

Unfortunately visual determination is unreliable and inconsistent complicated by inability of shade guides to

cover the entire dental shade range, a lack of logical and ordered arrangement of the shade tabs and operator and lighting variables such as aging, visual fatigue, lighting conditions and metamerism respectively.<sup>1,2</sup>

Hence, a clinical study is planned to perform visual shade selection in standardized conditions to correlate the shades of the maxillary anterior natural teeth in the adult subjects of Davangere district origin to one acrylic and three porcelain shade guides commercially available in India.

### MATERIALS AND METHODS

#### Armamentarium

1. Vitapan 3D master tooth guide system (Vita Zahnfabrik H Rauter GmbH Germany) (Fig. 1).
2. Vitapan classic shade guide (Vita Zahnfabrik) (Fig. 2).
3. Ivoclar chromascop shade guide (Ivoclar Vivadent, Liechtenstein) (Fig. 3).
4. Acrylux V acrylic shade guide (Ruthenium Dental Manufacturing SPA Rovigo, Italy) (Fig. 4).
5. Osram Biolux 72-965 color corrected full spectrum daylight fluorescent tubes.

#### Source of Data

The study was conducted in adult samples of Davangere district origin, randomly selected irrespective of gender. They were grouped into three age groups as follows.

Groups	Age range (in years)	Sample size
1	18-30	50
2	31-40	50
3	41-50	50

Practical exclusion criteria were applied in selecting the subjects for the study.



Fig. 1: Vitapan 3D master shade guide



Fig. 2: Vitapan classical shade guide



Fig. 3: Ivoclar chromascop shade guide



Fig. 4: Acrylux V acrylic shade guide

All subjects selected for the study had natural maxillary anterior teeth with no caries, restorations, intrinsic stains or active orthodontic treatment that could interfere with the shade selection procedure and no history of tobacco abuse.

### Proforma

A proforma was used for the purpose of recording the personal details, the dental history as well as the shade values selected for each shade guide for all the subjects used in the study.

### Light Source

In order to standardize the light source, ceiling mounted florescent tube fixtures were installed with Osram Biolux 72-965 (Osram GmbH, Germany) full spectrum natural daylight color corrected fluorescent tubes (6 nos.) in the ceramic laboratory of Department of Prosthodontics, Bapuji Dental College and Hospital. The fluorescent tube fulfilled the specification of standardized light source to be used for dental shade selection which was as follows:

Color temperature	6,500 K
Color rendering index	>90
Light intensity	2,300 lm

These specifications closely approximate the standardized natural daylight source.

### Shade Selection Procedure

The subject was positioned upright with the mouth at the clinician’s eye level and the clinician’s position at an arms length from the subject.

1. A total of 5 clinicians participated in the study. All clinicians were screened for color vision deficiency with Ishihara test for color blindness and no color vision deficiencies were found.
2. The shade tabs were positioned adjacent to the maxillary central incisor and the clinicians concentrated only on the middle one-third of the facial surface to determine the correct shade. Shade tabs were rapidly scanned from the darker shades by the procedure of elimination to determine the best possible match within a time limit of 10 seconds. The shade tabs were also viewed from different angles and both the tooth and the shade guide tabs were maintained in a moist condition.

The data collected from the proforma for all the 150 samples studied was tabulated to obtain a master chart for all the shades matched for the four shade guides.

## STATISTICAL ANALYSIS

The statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 10 statistical software. Cross tabulation and Chi-square analysis between each shade guide and the three age groups was done.

## RESULTS

The aim of the present study was to correlate the shades of the maxillary anterior natural teeth of the adults of the Davangere district origin with the commercially available shade guides and to determine predominant shade values for each of the shade guides.

As listed in Table 1 under the Vitapan 3D master shade guide 72, 69.3 and 60% of the samples were matched to the second value group of the shade guide (2L 1.5, 2M2 and 2M1) in the three age groups respectively. The total percentage of 67.1 % was found in total number of samples studied. The lower value group 3 of the shade guide matched to 2, 14 and 34% in the three age groups respectively with a total percentage of 16.7% for all the samples. However, only two samples were matched to the value group 4 yielding a percentage of only 1.4% and no subjects were matched to the value group 5 of the shade guide. Thus, the subjects studied had very low prevalence of low value (darker) groups 3, 4 and 5 of the Vitapan 3D master shade guide. There was significant correlation between the shades of the Vitapan 3D master shade guide and the different age groups when the Chi-square test was applied ( $p < 0.05$ ).

The Vitapan classic shade guide is arranged according to hues in four groups A, B, C and D with the tabs arranged in the order of increasing chroma within the four hue groups (A1, A2, A3.....A4) and value differences were not easily determined. As observed in Table 1 there was a relatively uniform distribution of subjects in percentages 32.2, 22.8, 26.2 and 18.8% in the A, B, C, D groups respectively. However as observed in the Vitapan 3D master Shade guide the higher value (brighter) shades in each of the four hue groups were more prevalent in all subjects studied. The cross tabulation of Vitapan classic shade guide with the age groups showed significant correlation of the shades over all age groups ( $p < 0.001$ ) as listed in Table 2.

The cross tabulation of the Acrylux V acrylic shade guide with age groups shown in Table 3 revealed the prevalence of subjects in the A (35.3%) and D (44.0%) shade groups. A shade group was more prevalent in the age group 1 (52%) but decreased in age group 3 (4%). D shade group was more prevalent in the age groups 2 (49%) and 3 (52%). The correlation was significant ( $p < 0.001$ ) for the Chi-square test.

The cross tabulation of Ivoclar Chromascop shade guide with the three age groups showed the first hue group to be most prevalent across all the age groups (85.9%). In the age group 1 all shades matched were limited to the 1st hue group of the shade guide (100%) that decreased slightly in the age group 2 samples (95.9%). Age group 3 showed a decrease in the samples matched to the 1st hue group to 62%. Significant correlation was also found between the Ivoclar Chromascop shades and the different age groups ( $p < 0.001$ ) by Chi-square analysis as shown in Table 4.

**Table 1:** Vitapan 3D master shade guide vs age cross tabulation

	Shade value	18-30 years (n = 50)	% of 50	31-40 years (n = 49)	% of 49	41-50 years (n = 50)	% of 50	Total (n = 149)	Total group (%)
1st value group	1M1	4	26%	3	16.3%	0	2%	22	14.8%
	1M2	9		5		1			
2nd value group	2L 1.5	14	72%	8	69.3%	5	60%	100	67.1%
	2L 2.5	1		1		3			
	2M1	7		10		5			
	2M2	8		8		10			
	2M3	1				2			
	2R 1.5	5		5		2			
3rd value group	2R 2.5	0		2		3		25	16.7%
	3L 1.5	0	2%	2	14.3%	7	34%		
	3L 2.5	0				1			
	3M1	0		1		2			
	3M2	1		3		6			
4th value group	3R 1.5	0		1		1		2	1.4%
	4L 1.5	0	0%	0	0%	1	4%		
	4M1	0		0		1			
Total		50	100%	49	100%	50	100%	149	100%
<i>Chi-square tests</i>									
		<i>Value</i>			<i>df</i>			<i>Asymp. sig. (2-sided)</i>	
Pearson Chi-square		45.951			30			0.031	
Number of valid cases		149							

**Table 2:** Vitapan classical shade guide vs age cross tabulation

Hue groups	Shade value	18-30 years (n = 50)	% of 50	31-40 years (n = 49)	% of 49	41-50 years (n = 50)	% of 50	Total (n = 149)	% of 149	Total group (%)
A	A1	16	32%	14	28.6%	1	2%	31	20.8%	32.2%
	A2	1	2%	7	14.3%	4	8%	12	8.0%	
	A3	1	2%	0	0%	4	8%	5	3.3%	
B	B1	9	18%	3	18.4%	0	0%	12	8.0%	22.8%
	B2	7	14%	5	10.2%	7	14%	19	12.7%	
	B3	0	0%	1	2.0%	2	4%	3	2.0%	
C	C1	13	26%	9	18.4%	8	16%	30	20.1%	26.2%
	C2	0	0%	1	2.0%	3	6%	4	2.7%	
	C3	2	4%	0	0%	3	6%	5	3.3%	
D	D2	1	2%	6	12.2%	9	18%	16	10.7%	18.8%
	D3	0	0%	3	6.1%	6	12%	9	6.0%	
	D4	0	0%	0	0%	3	6%	3	2.0%	
Total		50	100%	49	100%	50	100%	149	100%	100%
<i>Chi-square tests</i>										
			<i>Value</i>				<i>df</i>	<i>Asymp. sig. (2-sided)</i>		
Pearson chi-square			61.039				22	0.000		
Number of valid cases			149							

**Table 3:** Acrylux acrylic shade guide vs age cross tabulation

Shade groups	Shade values	18-30 years (n = 50)	% of 50	31-40 years (n = 49)	% of 49	41-50 years (n = 50)	% of 50	Total	% of 150	Total group (%)
A	A1	26	52%	9	18.4%	2	4%	37	24.7%	35.3%
	A2	0	0%	3	6.1%	8	16%	11	2.2%	
	A3	0	0%	0	0%	5	10%	5	3.3%	
B	B2	3	6%	3	6.1%	3	6%	9	6.0%	6.0%
C	C1	5	10%	10	20.4%	3	6%	18	12%	14.7%
	C2	0	0%	1	2.0%	1	2%	2	1.2%	
	C3	0	0%	0	0%	2	2%	2	1.2%	
D	D2	10	32%	14	28.6%	12	24%	36	24.0%	44%
	D3	6	0%	8	16.3%	12	24%	26	17.3%	
	D4	0	0%	2	4.1%	2	4%	4	2.7%	
Total		50	100%	50	100%	50	100%	150	100%	100%
<i>Chi-square tests</i>										
			<i>Value</i>				<i>df</i>	<i>Asymp. sig. (2-sided)</i>		
Pearson chi-square			57.766				18	0.000		
Number of valid cases			150							

The second objective of the study was to determine the predominant shade values that are as follows:

The Vitapan 3D master shade guide showed the predominant shade values as:

Shade value	No. (total 150)
2L1.5	27 (18.0%)
2M2	26 (17.2%)
2M1	22 (14.6%)

Comparisons of the above predominant shades within different age groups showed significant correlation ( $p < 0.05$ ) only for the decrease in the value of 2L 1.5 from age group 1 to age group 3 by Fisher's exact test. The other two predominant shades 2M2 and 2M1 were uniformly

distributed in the three age groups and did not show any statistically significant decrease in the older age groups 2 and 3. The predominant shades for the three age groups are displayed in Graph 1.

For the Vitapan classic shade guide the predominant shades found were:

Shade value	No. (total 150)
A1	31 (20.8%)
C1	30 (20.1%)
B2	19 (12.7%)
D2	16 (10.7%)

Comparisons of the above predominant shades between different age groups showed significant correlation

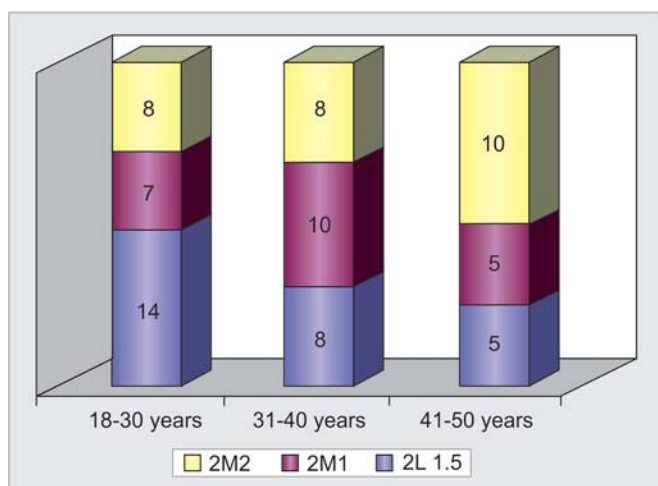


**Table 4:** Ivoclar Chromascop shade guide vs age cross tabulation

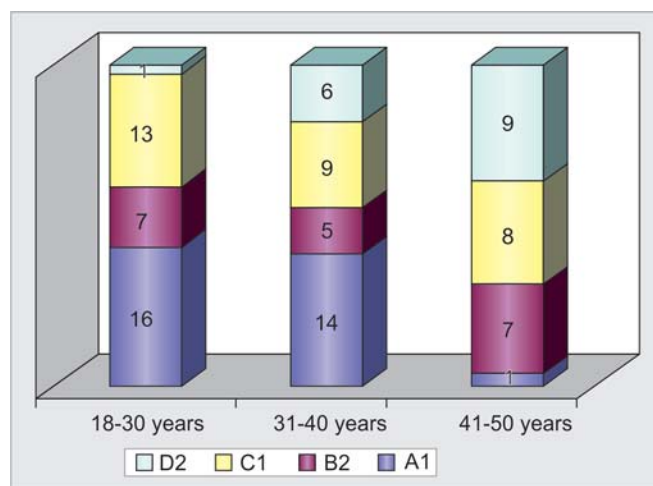
Hue groups	Shade values	18-30 years (n = 50)	% of 50	31-40 years (n = 49)	% of 49	41-50 years (n = 50)	% of 50	Total	% of 149	Total group (%)
1	110	30	60%	14	28.6%	6	12%	50	33.5%	85.9%
	120	5	10%	15	30.6%	3	6%	23	15.4%	
	130	11	22%	11	22.4%	15	30%	37	24.8%	
	140	4	8%	7	14.3%	7	14%	18	12.1%	
2	210	0	0%	1	2.0%	4	8%	5	3.3%	3.3%
3	310	0	0%	0	0%	1	2%	1	0.7%	0.7%
4	410	0	0%	0	0%	3	6%	3	2.0%	7.4%
	420	0	0%	0	0%	3	6%	3	2.0%	
	430	0	0%	0	0%	4	8%	4	2.7%	
	440	0	0%	0	0%	1	2%	1	0.7%	
5	510	0	0%	1	2.0%	3	6%	4	2.7%	2.7%
Total		50	100%	49	100%	50	100%	149	100%	100%

Chi-square tests			
	Value	df	Asymp. sig. (2-sided)
Pearson chi-square	63.078	20	0.000
Number of valid cases	149		



**Graph 1:** Vitapan 3D master predominant shades



**Graph 2:** Vitapan classic predominant shades

( $p < 0.001$ ) in the decrease in the no. of A1 shade toward the age group 3. The second most predominant shade C1 did not decrease significantly in older age groups and the shade B2 was uniformly distributed in the three age groups. Significant correlation ( $p < 0.05$ ) was also found in the increase in the value of shade D2 between age groups 1 and 3 as determined by Fisher's exact test. However, it was matched to only 10.7% of the total samples studied. The predominant shades for the three age groups for the Vitapan classic shade guide are displayed in the Graph 2.

The predominant shade values for the Acrylux acrylic shade guide were:

Shade value	No. (total 150)
A1	37 (24.7%)
D2	36 (24.0%)
D3	26 (17.3%)

Comparisons of the predominant shade values showed significance ( $p < 0.05$ ) in the decrease of shade value A1 in the higher age groups by Fisher's exact test. The other two predominant shades D2 and D3 did not show any significant difference within the three age groups. The predominant values for the three age groups for the Acrylux shade guide are displayed in Graph 3.

The predominant shades determined for the Ivoclar Chromascop shade guide were:

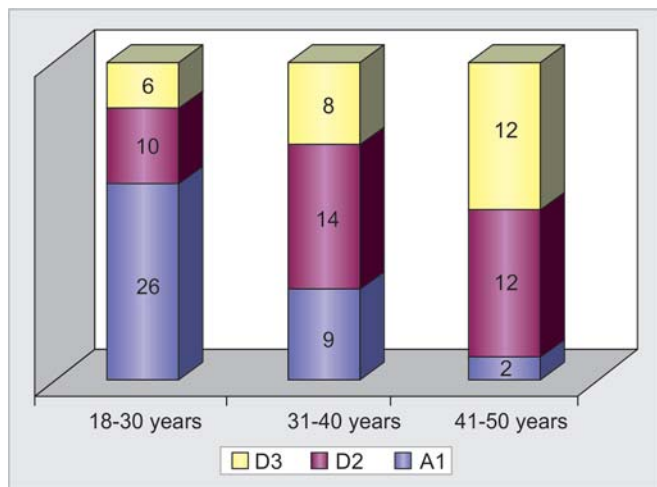
Shade value	No. (total 150)
110	50 (33.5%)
130	37 (24.8%)
120	23 (15.4%)

Significant correlation ( $p < 0.05$ ) was found in the decrease of the shade 110 from age groups 1 to 3. The 2nd

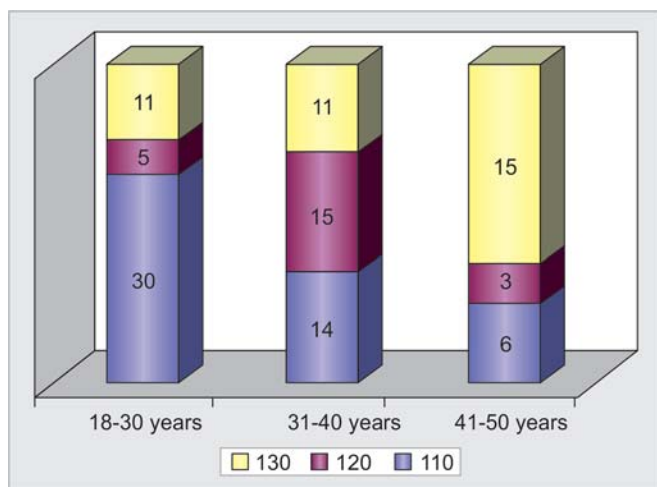
most predominant shade 130 increased in the age group 3 but this observation was not significant. The shade 120 was more prevalent in the age group 2 as compared to age groups 1 and 3, which was also found to be statistically significant ( $p < 0.05$ ) by Fisher's exact test. The predominant shades for the Ivoclar Chromascop shade guide in the three age groups are displayed in Graph 4.

**DISCUSSION**

Shade selection is critical to the success of any dental restoration as it enables the fabrication of highly esthetic restoration that mimics the color of the neighboring natural teeth. Numerous studies have been performed using both visual and colorimetric analysis to determine the predominant shade values of natural anterior maxillary teeth but they have been limited to population samples of American and European origin.<sup>3-6</sup> Hence, the study was planned to perform visual shade selection to correlate one acrylic and three porcelain shade guides to a sample of adults of Davangere district origin in the Indian population.



**Graph 3:** Acrylux V acrylic predominant shades



**Graph 4:** Ivoclar Chromascop predominant shades

The results of this study showed that all the four shade guides were significantly correlated to the adults of the Davangere district origin (Tables 1 to 4). Hence, each of these shade guides can be used for shade selection by clinicians in daily dental practice.

In the first age group 98% of subjects matched to the first and second value group of the Vitapan 3D master shade guide. In the second age group 84% of the samples were again matched to the same value groups that decreased to 62% in the third age group to a total of 60%. Thus, predominant percentages of subjects in all the age groups had higher value shades that suggest that Davangere district population tends to have lighter shades.

In the present clinical study Vita 3D master shade guide was found to be the easiest to correlate to the teeth of the subjects as:

- There were more shade tabs (26) in the shade guide hence there was more choice available to match the closest acceptable shade tab.
- Due to the logical arrangement of shade tabs first the basic value group was determined for each subjects followed by the chroma and hue respectively.

The Vitapan classic shade guide is the most popular shade guide available today. In the present study rapid determination of the most acceptable shade match was not possible due to the unordered arrangement of the shade tabs in the Vitapan classic shade guide.

This was also reported by several investigators who found inadequacies in this shade guide with respect to the total color coverage of natural human teeth of only 11%.<sup>7</sup>

The three most predominant shades found for the Acrylux V acrylic shade guide were A1, D2 and D3. However, A1 and A2 shades that accounted for 48% of the samples studied were the brighter shades in their respective color groups. Hence, this shade guide also confirmed the findings of the Vita shade guides regarding the prevalence of the brighter shades in the samples studied.

The Ivoclar Chromascop shade guide could not be correlated accurately for the older age groups 2 and 3, which explain why 33% of the shades belonged to 110 shade in the 1st hue group. As observed from Table 5, 128 out of 149 samples studied, i.e. 85% were limited to the first hue group. However, as was found in the correlation of the other 3 shade guides the higher value shades were most frequently matched for the sample population.

Hence, for all the shade guides the highest value shades observed most predominantly in all the subjects studied were 2L 1.5, A1, A1 and 110 respectively.

There was significance in the decrease in the number of samples matched for these predominant shades in the 1st to

3rd age group, however, lower value shades for any other shade guides were not prevalent in adequate numbers. It has been reported in the literature that teeth tend to darken and become more reddish beyond 35 years of age due to secondary dentin deposition,<sup>4</sup> a finding that was not observed in the present study. This could be attributed to the characteristic of the race within the limitation of the study. This finding was also observed in the colorimetric analysis of 87 natural teeth of Japanese subjects and comparison with the Vitapan classic shade guide.<sup>3</sup>

From a clinical standpoint the eye is very accurate in detecting homogeneities and variations in small surfaces.<sup>8</sup> The eyes can perceive up to 300 spectral colors and is better capable of detecting value dimension of color due to the higher number of rods (100 million) present as compared to the cones (approximately 6 millions) which are responsible for hue and chroma determination.<sup>9</sup> Hence, value is the most important dimension of color to be matched and should be given preference in the shade determination procedure. The precise communication of the shade, tooth anatomy and subsequent accuracy of porcelain fabrication by the laboratory are equally important for a pleasing final esthetic restoration.

## CONCLUSION

The following conclusions can be drawn from the study.

1. The Vitapan 3D master shade guide was easiest to correlate to the population sample studied.
2. From the study it was concluded that the Davangere district population had more prevalence of higher value (brighter) shades in all the three different age groups studied.

## CLINICAL SIGNIFICANCE

The study was limited by the inadequacies of the current shade guides; the subjectiveness of the data obtained which was qualitative as the shade guides do not provide accurate quantifiable color data for analysis and interpretation and the subjectiveness of the shade perception by human observers. Thus, future *in vivo* and *in vitro* spectrophotometric studies are necessary for larger and more representative sample of the population to correlate to the findings of the present study.

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