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Research Article

Shade Selection in Dentistry

A Comparison Between Visual, Digital Photography, And Polarizing Filter Photography for Shade Selection Among the Adult Jeddah Population

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Abstract: Shade selection plays an important role in esthetic dentistry. Modern dentistry has various methods of shade selection, such as visual, digital, and polarized filter methods. Hence, our aim of this study was to determine which of the three named methods was more accurate for shade selection in aesthetic dentistry, and study objectives of the study were to assess the shade of a maxillary central incisor by visual, digital and polarized filter method and to find out which is more suited for shade selection. This clinical observational (analytical, cross-sectional, and descriptive) study was conducted at Ibn Sina National College for Medical Studies, Jeddah. A total of 80 participants were selected randomly. For each all the participants, shade selection was performed by visual, digital, and polarized filter methods. SPSS version 21 was used to perform the statistical analysis. A Chi-square test was applied for qualitative variables to find the association. The level of significance is set at 0.05. Among the participants, 52 (65.0%) participants were female, (35.0%) participants were male, and the minimum age of them was 20, whereas the maximum ages were 50. Among the population pool of the study, 52 (65%) and 28 (35%) participants were female and male, respectively. The minimum age of the participants was 20, and the maximum was 50 years. The study results showed that a polarized filter shade selection method was the most accurate among the three methods of shade selection. It is recommended to select a shade for the esthetic procedures by combining visual, digital, and polarizing filter methods to get accurate shade. It should be added as a part of the curriculum, and emphasis should be given to the various techniques of shade selection.

Keywords Digital method, Dental technician, Dental practitioners, Esthetic dentistry, polarizing filter method, Shade selection, and Visual method.

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1. INTRODUCTION

The fixed dental prosthesis has become a worldwide treatment option for numerous partially edentulous patients because of its esthetic effect, and it is indirectly fabricated in a dental laboratory.[1] All dental patients have a greater understanding of the importance of cosmetic restorations. Thus dentists are responsible for offering restorations that can blend in with the natural dentition around them. Now have a greater understanding of the importance of cosmetic restorations. Therefore, a dentist must offer restorations that can blend in with the natural dentition around them.[2]Dental practitioners face many aesthetic challenges, especially restorative, crown and bridge, and Implant prosthesis procedures. Dental practitioners must focus more on shade selection for a good esthetic result. [3-5] One of the main causes of aesthetic failure is shade, particularly in the anterior region, selection, an essential component of cosmetic dentistry. Dentists must efficiently transfer this information to the laboratory to build beautiful restorations that blend with surrounding natural teeth. There are various ways to choose a color. The traditional method involves visually comparing a dental shade guide that is readily available to the desired tooth. Nevertheless, various factors, including varying light sources and variations in how people view color, contribute to perception errors. The ability to provide the intended results may change due to these considerations.[6] The shade selection is challenging since the natural tooth is polychromatic and represents complex characteristics. Dentin confers the based color of a dental element, or the hue, while the enamel modifies the Chroma and the value of the hue according to its different thickness[7-9]. In the cervical third of the natural tooth, the enamel is usually thin and generally darker compared to the middle third and incisal third. That is why this area is suggested to use as a reference for hue selection.[7] In addition, other factors that influence the color determination of the teeth are surface texture, translucency, and color of the surrounding area. [10] Different shade selection techniques are available, such as visual, Instrumental, and Digital methods. The Visual method is commonly used because it is simple, cost-effective, and gives good results. [11-12] There are many advantages in using the visual method for shade selection. The main advantage is the confirmation of the shade by the patient, which the clinician selects. So many factors must be considered when selecting the shade by visual method. Both clinician and patient should have good eye vision, clinician's experience, color perception, eye fatigue, and clinical environment, which include a source of light, the color of the chair and walls, and the degree of light intensity.[13-14][15-17]At present; some dental practitioners started using digital technologies such as intraoral scanners and 3D printing to achieve clinical success. Additionally, digital and smartphone cameras were used for the shade selection to enhance esthetic results. One of the most substantial tools in communicating with patients and technicians is digital photography, by assisting with visualizing the morphology, color, and texture of the teeth.[18,19] Right software can be utilized to enhance the quality of the photos. This gives the color value for such photos' entire or a selected portion. The tooth shade can be objectively evaluated and sent to the technician through the Internet, providing further details about the restoration that will be created.[20, 22] Digital photography using a polarizing filter delivers the greatest amount of objective information on tooth color, texture, and anatomy for proper communication with the dental laboratory technician for a successful restorative outcome[19,21] A polarizing filter reduces reflections and glare while boosting color saturation in an image. In addition, it improves translucency and makes the true polychromatic nature of teeth easier to see.[20, 24] The purpose of this study was to compare three methods, visual, digital, and polarizing filter photography methods, and find out which would be best suitable for shade selection in aesthetic dentistry and whether experience affects the capacity for accurate shade selection. There was no discernible difference in the shade selection techniques under investigation, according to the null hypothesis of this study.

2. MATERIALS AND METHODS

This cross-sectional study was conducted in the Department of Oral and Maxillofacial Rehabilitation, dental OPD of Dentistry program, IbnSina National College for Medical Studies, Jeddah, Saudi Arabia. 80 participants were involved in this study. Only the maxillary right central tooth was used to perform shade selection.[24]

2.1 Ethical statement

Ethical approval was obtained from the Institution Research Review Board, Ibn Sina National College of Medical Studies, Jeddah, Saudi Arabia, for conducting a clinical observational (analytical, cross-sectional, and descriptive) study. (Ref: IRRB-06-04082022).[25]

2.2 Study design

This clinical study was observational (analytical, cross-sectional, and descriptive).

2.3 Sample size

The following simple formula was used for calculating the adequate sample size in the prevalence study Z1-a/2 2 p (1-p)/ d2**,** where n is the sample size, Z is the statistic corresponding to the level of confidence, P is expected prevalence[26] (that can be obtained from same studies or a pilot study conducted by other authors. 80 participants were selected based on inclusion and exclusion criteria for this study.

2.4 Inclusion criteria

All the participants were 20-50 years old. Equal sex distribution. Completely edentulous. Should have good oral hygiene

2.5 Exclusion criteria

All the participants should not have Malformed anterior teeth. Defects in the anterior teeth, should not have undergone orthodontic treatment, endodontic treatment and bleaching procedures.

2.6 Determination of tooth shade by three methods:

2.6.1 Visual method:

VITA classical shade guides were used for this study. Eleven shades were selected from the shade guide (A1, A2, A3.5, B1, B2, B3, C1, C2, C3, D1 and D2) and the shade number was concealed. The selected tabs depicted the most common shades used in a clinical setup. An Observer was given one concealed shade tab in a random sequence and was asked to identify the shade from the control shade guide (in natural daylight).[2, 27]

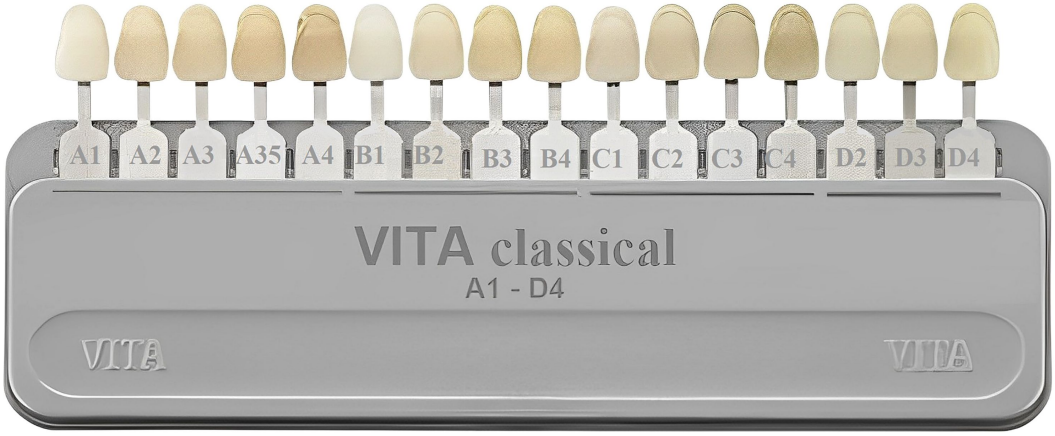

Fig 1: displays Vita shade guide

Fig 2: depicts shade selection by the visual method

2.7 Digital photographic method

Digital photographs of each selected shade tab from the control group were captured individually to prepare a digital photographic shade guide. The shade tabs were kept at 30 cm from the camera. Each tab was placed at the patient's right central incisor to capture images of the concealed shade tabs. The prepared digital control shade guide was layered above each captured photograph of the concealed shade tab. Thus Photoshop document files (PSD) were developed for matching.[2, 27]

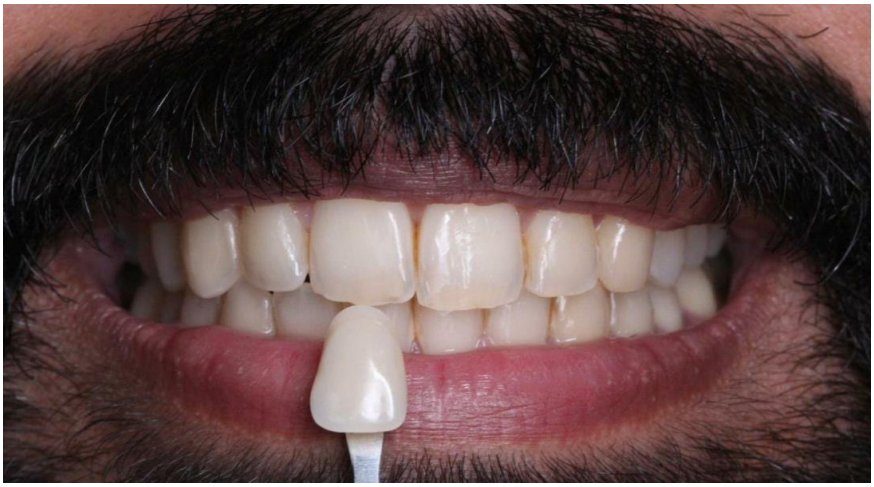

Fig 3: Illustrates shade selection by the digital method:

2.8 Polarizing filter photographic method:

A circular polarizing filter was attached to the Canon 5D camera. Photographs of the control shade tab were captured using a polarizing filter to prepare a polarized shade guide. Images of the patient's teeth with concealed shade tab at the right central incisor position and missing adjacent central incisor were taken. An actual shade was selected by using the

Vita shade guide. It was verified with the digital and polarizing filter methods for all the patients. Similar methods were used[2, 27-29]. The 18 PSD files (digital photographs, nine polarizing filter photographs) were coded as per the concealment of the shade tabs. Once the shade was matched, the observation was noted, and the next file was presented for shade selection.

Fig 4: Illustrates shade selection by the polarized filter method:

3. STATISTICAL ANALYSIS

(Statistical Package for Social Sciences) version 20. (IBM SPASS statistics [IBM Corp. released 2011] was used for statistical analysis. Data was entered in the Excel spreadsheet. The mean and standard deviation for quantitative variables, frequency, and proportions for qualitative variables calculated descriptive statistics of the explanatory and outcome variables. Inferential statistics like the Chi-square test were applied for qualitative variables to find the association. The level of significance is set at 0.05.

4. RESULTS

This study was proposed to assess the shade of the maxillary central incisor by visual, digital, and polarized filter methods and analyze which technique is more accurate for shade selection. Table 2 illustrates the estimation of the distribution of the subjects based on gender. Among the participants, 52 (65.0%) participants were female, (35.0%) participants were male, and the total number of participants in this study was 80 (100.0%).

Table1: Demographic data

1.	Gender	Male	28
		Female	52
2.	Age	20-30 years	56
		31-40 years	16
		41-50 years	8
3.	Education	High school graduate or less	08
		Graduate	60
		Postgraduate	12
4.	Occupation	Students and interns	45
		Teachers and professors	12
		Businessman	10
		Housewife	13

Table 2: Camera and flash settings

Parameters	Setting selected
Magnification	A 1:1 ratio was selected Exposure
mode	Automatic
White balance	Automatic
Aperture	Automatic
Flash	TTL flash metering
Manual flash mode	Off
Fixed white balance	Off
Image resolution	"High" image resolution selected
File type	JPEG with the same degree of image compression
ISO value	800
Shutter speed	1/25
Flash speed	1/1

Table 3: Distribution of the subjects based on gender		
Gender	**Frequency**	**Percent**
Females	52	65.0
Males	28	35.0
Total	**80**	**100.0**

Table 3 illustrates the estimation of the mean age distribution of the subjects. The participants' minimum age was 20, whereas the maximum ages were 50, the mean values were 26.11, and the stand deviation was 6.80.

Table 4: Mean age distribution of the subjects					
	N	**Minimum**	**Maximum**	**Mean**	**S.D**
Age	80	20.0	50.0	26.11	**6.80**

Table 4 illustrates the estimation of the distribution of the subjects based on age groups. Among the participants of this study, 56 (70.0%) were 20 to 30 years old. On the other hand, 16 (20.0%) belonged to the 31 to 40 age group and the 41 to 50 age group 8 (10.0%).

Table 5: Distribution of the subjects based on age groups.		
Age Groups	**Frequency**	**Percent**
20 to 30 yrs.	56	70.0
31 to 40 yrs.	16	20.0
41 to 50 yrs.	8	10.0
Total	80	100.0

Table 5 illustrates the estimation of cross-tabulation of actual shade with a visual method. Among the female participants, 14 (26.9%) had A1 shade, 14 (26.9%) had A2 shade, 3 (5.8%) had A3 shade, 1 (1.9%) had A 3.5 shade, 9 (17.3%) had B1 shade, 1 (1.9%) had B2 shade, 6 (11.5%) had C1 shade and 4 (7.7%) had D2. A Square value was 134.37, statistically significant (P<0.01). Among the male participants, 6 21.4% had A1 shade, 9 (32.1%) had A2 shade, 4 (14.3%) had A3 shade, 1 (3.6%) had A 3.5 shade, 1 (3.6%) had B1 shade, 1 (3.6%) had B2 shade, 1(3.6%) had B3 shade, 2 (7.1%) had C1 shade and 3 (10.7%) had D2 shade. A Square value was 153.43, which was statistically significant (P=0.01).

Table 6: Cross-tabulation of actual shade with the visual method														
Gender	**Visual Method**		**Actual Shade**									**Total**	**Sq value**	**P value**
			A1	A2	A3	B1	B2	B3	C1	C2	D2			
Females	A1	Count	10	2	0	2			0	30.0%	0	14	134.37	0.001*
		%	19.2%	3.8%	0.0%	3.8%			0.0%		0.0%	26.9%		
	A2	Count	1	11	1	0			1		0	14		
		%	1.9%	21.2%	1.9%	0.0%			1.9%		0.0%	26.9%		
	A3	Count	0	0	3	0			0		0	3		
		%	0.0%	0.0%	5.8%	0.0%			0.0%		0.0%	5.8%		
	A3.5	Count	0	0	1	0			0		0	1		
		%	0.0%	0.0%	1.9%	0.0%			0.0%		0.0%	1.9%		
	B1	Count	1	0	0	0			0		0	0		
		%	1.9%	0.0%	0.0%	15.4%			0.0%		0.0%	17.3%		
	B2	Count	0	1	0	0			0		0	1		
		%	0.0%	1.9%	0.0%	0.0%			0.0%		0.0%	1.9%		
	C1	Count	2	0	0	0			4		0	6		
		%	3.8%	0.0%	0.0%	0.0%			7.7%		0.0%	11.5%		
	D2	Count	1	2	0	0			0		1	4		
		%	1.9%	3.8	0.0%	0.0%			0.0%		1.9%	7.7%		
	Total	Count	15	16	5	10			5		1	52		
		%	28.8%	30.8%	9.6%	19.2%			9.6%		1.9%	100.0%		
Males	A1	Count	5	0	0	1	0	0	0	0	0	6	153.43	0.001*
		%	17.9%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	21.4%		
	A2	Count	1	7	0	0	1	0	0	0	0	9		
		%	3.6%	25.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	32.1%		
	A3	Count	0	1	2	0	1	0	0	0	0	4		
		%	0.0%	3.6%	7.1%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	14.3%		
	B1	Count	0	0	0	1	0	0	0	0	0	1		
		%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%		
	B2	Count	0	0	1	0	0	0	0	0	0	1		
		%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%		

B3	Count	0	0	0	0	0	1	0	0	0	1
	%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	3.6%
C1	Count	0	0	0	0	0	0	1	0	0	1
	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6	0.0%	0.0%	3.6%
C2	Count	0	0	0	0	0	0	0	2	0	2
	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%	0.0%	7.1%
D2	Count	0	1	0	0	0	0	0	0	2	3
	%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%	10.7%
Total	Count	6	9	3	2	2	1	1	2	2	28
	%	21.4%	32.1%	10.7%	7.1%	7.1%	3.6%	3.6%	7.1	7.1%	100.0%

Table 6 illustrates the estimation of cross-tabulation of actual shade with the digital method. Among the female participants, 14 (26.9%) had A1 shade, 14 (26.9%) had A2 shade, 3 (5.8%) had A3 shade, 1 (1.9%) had A 3.5 shade, 9 (17.3%) had B1 shade, 1 (1.9%) had B2 shade, 6 (11.5%) had C1 shade and 4 (7.7%) had D2. The square value was 134.37, which was statistically significant (P<0.01). Among the male participants, 6 (21.4%) had A1 shade, 9 (32.1%) had A2 shade, 4 (14.3%) had A3 shade, 1 (3.6%) had A 3.5 shade, 1 (3.6%) had B1 shade, 1 (3.6%) had B2 shade, 1(3.6%) had B3 shade, 2 (7.1%) had C1 shade and 3 (10.7%) had D2 shade. The square value was 153.43, which was statistically significant (P=0.01).

Table 7: Cross-tabulation of the actual shade with the polarized filter method.

Gender	Visual Method		Actual Shade									Total	Sq value	P value
			A1	A2	A3	B1	B2	B3	C1	C2	D2			
Females	A1	Count	13	1	0	2			1		0	17	14	0.001*
		%	25.0%	1.9%	0.0%	3.8%			1.9%		0.0%	32.7%	9.46	
	A2	Count	0	10	1	0			0		0	11		
		%	0.0%	19.2%	1.9%	0.0%			0.0%		0.0%	21.2%		
	A3	Count	0	0	4	0			0		0	4		
		%	0.0%	0.0%	7.7%	0.0%			0.0%		0.0%	7.7%		
	B1	Count	1	1	0	8			0		0	10		
		%	1.9%	1.9%	0.0%	15.4%			0.0%		0.0%	19.2%		
	B2	Count	0	1	0	0			0		0	1		
		%	0.0%	1.9%	0.0%	0.0%			0.0%		0.0%	1.9%		
	C1	Count	0	3	0	0			4		0	7		
		%	0.0%	5.8%	0.0%	0.0%			7.7%		0.0%	13.5%		
	D2	Count	1	0	0	0			0		1	2		
		%	1.9%	0.0%	0.0%	0.0%			0.0%		1.9%	3.8%		
	Total	Count	15	16	5	10			5		1	52		
		%	20.8%	30.8%	9.6%	19.2%			9.6%		1.9%	100%		
Males	A1	Count	3	2	0	1	0	0	0	0	0	6	121.07	0.001*
		%	10.7%	7.1%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	21.4%		
	A2	Count	1	6	1	0	1	0	0	0	0	9		
		%	3.6%	21.4%	3.6%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	32.1%		
	A3	Count	0	0	2	0	0	0	0	0	1	3		
		%	0.0%	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	10.7%		
	B1	Count	2	0	0	1	0	0	0	0	0	3		
		%	7.1%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	10.7%		
	B2	Count	0	0	0	0	1	0	0	0	0	1		
		%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%		
	B3	Count	0	0	0	0	1	0	0	0	0	1		
		%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	3.6%		
	C1	Count	0	0	0	0	0	0	1	1	0	2		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	3.6%	0.0%	7.1%		
	C2	Count	0	1	0	0	0	0	0	0	0	1		
		%	0.0%	3.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%		
	C3	Count	0	0	0	0	0	0	0	1	0	1		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	3.6%		
	D2	Count	0	0	0	0	0	0	0	0	1	1		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	3.6%		
	Total	Count	6	9	3	2	2	1	1	2	2	28		
		%	21.4%	32.1%	10.7%	7.1%	7.1%	3.6%	3.6%	7.1%	7.1%	100%		

Table 7 shows the estimation of cross-tabulation of actual shade with the polarizing filter method. Among the female participants, 17 (32.7%) had A1 shade, 11 (21.2%) had A2 shade, 4 (7.7%) had A3 shade, 10 (19.2%) had B1 shade, 1 (1.9%) had B2 shade, 7

(13.5%) had D2 shade, 2 (3.8%). The square value was 145.62, which was statistically significant (P<0.01). Among the male participants, 6 (21.4%) had A1 shade, 9 (32.1%) had A2 shade, 3 (10.7%) had A3 shade, 3 (10.7%) had A 3.5 shade, 3 (10.7%) had B1 shade, 1 (3.6%) had B2 shade, 1(3.6%) had B3 shade, 2 (7.1%) had C1 shade, 1 (3.6) had C2 shade, 1 (3.6) and 1 (3.6%) had D2 shade. The square value was 153.43, which was statistically significant (P=0.01).

Table 8: Cross-tabulation of actual shade with the digital method.

Gender	Visual Method		ACTUAL SHADE									Total	Sq value	P value
			A1	A2	A3	B1	B2	B3	C1	C2	D2			
F	A1	Count	15	2	0	3			0		0	20	145.62	0.001*
		%	28.8%	3.8%	0.0%	5.8%			0.0%		0.0%	38.5%		
	A2	Count	0	12	1	1			0		1	15		
		%	0.0%	23.1%	1.9%	1.9%			0.0%		1.9%	28.8%		
	A3	Count	0	0	4	0			0		0	4		
		%	0.0%	0.0%	7.7%	0.0%			0.0%		0.0%	7.7.%		
	B1	Count	0	0	0	6			0		0	6		
		%	0.0%	0.0%	0.0%				0.0%		0.0%	1.5%		
	B2	Count		1	0	0			0		0	1		
		%	0.0%	1.9%	0.0%	0.0%			0.0%		0.0%	1.9%		
	C1	Count	0	1	0	0			5		0	6		
		%	0.0%	1.9%	0.0%	0.0%			9.6%		0.0%	11.5%		
	Total	Count	15	16	5	10			5		1	52		
		%	28.8%	30.8%	9.6%	19.2%			9.6%		1.9%	100%		
M	A1	Count	5	2	0	0			0		0	7	151.44	0.001*
		%	17.9%	7.1%	0.0%	0.0%			0.0%		0.0%	25.0%		
	A2	Count	0	7	0	0	0	00	0	0	0	7		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	25.0%		
	A3	Count	0	0	3	0	0	0	0	0	0	3		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	10.7%		
	B1	Count	1	0	0	2	0	0	0	0	0	3		
		%	3.6%	0.0%	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	10.75%		
	B2	Count	0	0	0	0	2	1	0	0	0	0		
		%	0.0%	0.0%	0.0%	0.0%	7.1%	3.6%	0.0%	0.0%	0.0%	0.0%		
	C1	Count	0	0	0	0	0	0	1	1	0	2		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	3.6%	0.0%	7.1%		
	C2	Count	0	0	0	0	0	0	0	1	0	1		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.6%	0.0%	3.6%		
	D2	Count	0	0	0	0	0	0	0	0	2	2		
		%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	7.1%	7.1%		
	Total	Count	6	9	3	2	2	1	1	2	2	28		
		%	21.4%	32.1%	10.7%	7.1%	7.1%	3.6%	3.6%	7.1%	7.1%	100%		

Table 8 depicts the number of correct and incorrect observations of this study. Most of the observations were correct with all three methods of shade selection. Correct observations by visual, digital, and polarized filter methods as 60 (75%), 59 (73.75), and 67 (83.75%), respectively. And incorrect observations by visual, digital, and polarized filter methods were 20 (25%), 21 (26.25), and 13 (16.25%).

Table9: Number of correct and incorrect observations in three methods

Method	Visual Shade selection	Digital shade selection	Polarizing Filter shade selection
Correct Observations	60 (75%)	59 (73.75)	67 (83.75%)
Incorrect Observations	20 (25%)	21 (26.25)	13 (16.25%)
Total Observations	80 (100)	80 (100%)	80 100%)

5. DISCUSSION

Modern dentistry is heading towards improved technology, which helps dental practitioners improve their skills and knowledge in their routine practice to treat patients proficiently. Their upgraded skills and knowledge help them to treat the patient proficiently.[30] Shade selection is one of the important procedure steps in the clinic and should be performed by the clinician and not left to the technician. That is why the study of shade selection is an essential part of esthetic dentistry. In the present study, shade selection was performed on the maxillary right central incisor for standardization, and due to its presence in the esthetic zone, it is very challenging in terms of shade matching and patient satisfaction. [6] Starting by the visual shade matching, Vita classical shade guide was chosen in this study due to its extensive use in dental clinics. With the increase of the number, the Chroma increases. At the same time, the value decreases [31, 32]. In contrast, Li. et al.., [33] and Zenthöfer., et al. [34,] who assessed the commercial shade guides, reported that the Vitapan 3D-Master shade guide was efficient and facilitated the shade selection in the clinic because the shade tabs were more evenly spaced in the color spectrum. In the current study, the shade tab was placed below the tooth, with the

incisal edge towards the tooth's incisal edge while selecting a shade for all the participants. This is in line with a study by Pitel ML [35]. Another study by Fondriest J [36] stated that most humans have eye dominance, and thus, it is not recommended to place the shade guide on the side of the tooth. Otherwise, one eye would preferentially perceive the shade, giving an inaccurate evaluation. He also reported that shade tabs should be positioned in the same plane of the tooth, neither in front of it, as it would appear lighter, nor behind it, as it would appear darker. In addition, a study by McLaren et al.[29] asserted that the environment of shade selection is very important, and he mentioned that the teeth needed to stay hydrated since teeth appear to be bright due to dehydration. That is why a medium-viscosity clear glaze liquid was used to wet the teeth and shade guide before doing shade selection procedures. This procedure was followed in our data collection. This clinical study selected a trained and experienced dental intern for shade. Two Prosthodontists were chosen as supervisors. According to Jaju.et.al[37] and Ristic et al. 38, clinical experience and knowledge of color science might improve the performance of shade selection so that it improves esthetics. Moreover, Clary et al.,[23], and Joshi and Acharya J[39] analyzed that there was no substantial gender effect for shade matching ability. The current study findings revealed that the polarized filter shade selection method was the most accurate among the three methods of shade selection. Results were found to be statistically significant (P value=0.01). A study by Louis Hardan, [40], found that color differences in restorations using a visual shade guide were higher than in digital photography. Furthermore, the proportion of incorrect shade guide tabs was used. Considering this, the null hypothesis stating that both digital and visual matching of the tooth were comparable was rejected. Using smartphones with polarizing filters allows clinicians to compare and evaluate color matching. The polarizing filter removes unwanted reflections and diffuses light created by the flash.[18] Study by Jared[22] et al. found that the observers accurately matched 43% of the shades by the Visual method of shade selection. Schropp[19] et al. compared digital photographs and graphic computer software for color matching with a visual method for shade selection in a simulated clinic. According to them, 32% was accurate with the visual shade matching method. The Key factor in obtaining an esthetic outcome with the restorations was perfect shade matching. In contrast, shade mismatching with ceramic restorations could be a headache for the patient and dental practitioners.[41-43] To attain perfect shade matching, it was recommended to utilize visual, digital, and polarizing filter methods. The visual method can be utilized to attain shade close to the natural tooth, and this method is affected by many factors such as experience, sex, the training of the observer, tooth shade, and source of light.[23] Dental technicians need accurate shade selection to fabricate crowns and bridges. Digital images will be very useful for the technicians to get details regarding color crossways, shape, and the surface of the prosthesis to be fabricated.[44] Furthermore, mobile dental photography (MDP) seems favorable regarding software applications, cost-effectiveness, enhanced functionalities, and high-resolution photographs, making it suitable for acquiring color references.

6. CONCLUSION

Within the limitations of the study, results of the study show that the polarized filter shade selection method was the most accurate among the three methods of shade selection. It is recommended to perform shade selection for the esthetic procedures by the combination of visual, digital, and polarizing filter methods to get accurate shade and should be added as a part of the curriculum, and emphasis should be given to the various techniques of shade selection. Education and training may improve an individual's shade-matching abilities.

7. LIMITATIONS OF THE STUDY

1. Selection of the patients for the study: Patient selection was tough; most patients who volunteered were either periodontally compromised or had caries in the anterior teeth.
2. Limited sample size: This study sample size was 80 patients who visited the dental OPD of Ibn Sina College for Medical Studies, Jeddah and restricted to the Makkah region of Saudi Arabia, and it is recommended to do further studies with a larger sample size.

8. RECOMMENDATIONS

Most Dentists are interested in learning shade selection technology. Hence, courses and workshops on shade selection are recommended to benefit general dental practitioners. In addition, techniques of shade selection should be added as a part of the curriculum, and emphasis should be given to the various techniques of shade selection.

9. AUTHOR'S CONTRIBUTION STATEMENT

Dr. Karunakar Shetty conceptualized the study, formulated the study design for this work, and was the manuscript's principal investigator and primary author. He also analyzed the collected data and coordinated with the statistician for the analysis of the data. Farah K. ALesayi, Aroub M. Albakri, Rahaf Q. Balah, Ashwag H. ALzahib, and Afrah ALunazi gathered the data, helped in the analysis of these data, and necessary inputs were given towards the designing of the manuscript. All authors discussed the methodology and results and contributed to the final manuscript.

10. CONFLICT OF INTEREST

Conflict of interest declared none.

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