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EVALUATION OF SHADE MATCHING PRACTICES AMONG NIGERIAN DENTISTS

Avaliação dos procedimentos de determinação de cor de restaurações entre dentistas niegerianos

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Abstract

OBJECTIVES: To assess tooth shade matching practices among Nigerian Dentists. **MATERIALS AND METHODS**: The data was collected by paper questionnaire mailed at random to dentists in some Nigerian Teaching Hospitals and General Hospitals. The questionnaires comprised of two aspects that inquired about their biographical data and basic methods of shade selection. About 95% of the questionnaires were retrieved and analyzed. **RESULTS**: 160 (83, males; 77 females) dentists participated in the study. 71% performed tooth shade matching often, with restorative dentists (100%) mostly involved than other specialists. 67% agreed that shade matching should be done in consultation with others. However, only 40.6% actually consults others during shade selection. Also, 85% of the dentists responded correctly that shade matching should be done under natural lights. However in their clinical practice, majority (97%) selected their teeth under dental lights. **CONCLUSION**: The study revealed that majority of the dentists practicing in the Nigerian Teaching and State Dental Hospitals are involved in shade matching practices. Majority of the dentists performed tooth matching procedure without concurrence from others and under dental light source. However few dentists reported complaints from their patients. Emphasizing color science in dental curriculum and teaching new shade matching systems could be essential for improved restorative outcomes.

Keywords: Tooth shade; Shade selection; Dentists Nigeria.

Resumo

OBJETIVOS*: Determinar os procedimentos de determinação de cor entre dentistas nigerianos.* ***MATERIAIS E MÉTODOS****: Os dados foram coletados por meio de questionários em papel, enviados aleatoriamente a dentistas em alguns hospitais de ensino e hospitais gerais. Os questionários compreenderam dois aspectos de questões sobre dados biográficos e métodos básicos de seleção de cores. Em torno de 95 % dos questionários foram recuperados e analisados.* ***RESULTADOS****: 160 dentistas (83 homens, 77 mulheres) participaram do estudo. 71% executam escolha de cores, sendo que 100% dos dentistas restauradores o fazem, em número bem maior do que as demais especialidades. 67% concordam que escolha da cor deve ser feita em conjunto com outras pessoas. Entretanto, somente 46,6 % realmente consultam uma segunda opinião durante a seleção de cores. Também 85% dos dentistas responderam que a escolha da cor deve ser feita sob luz natural. Entretanto, em sua prática clínica a maioria seleciona a cor sob luz de refletores.* ***CONCLUSÃO****: O estudo revelou que a maioria dos dentistas atuantes nos centros pesquisados praticam a seleção de cores dentárias. A maioria procede sem consultar segunda opinião e sob luzes de refletores. Entretanto, poucos dentistas relataram queixas de pacientes. A ênfase da ciência da cor no currículo dental e ensino de novos sistemas de escolha de cores poderia ser essencial para a melhora dos resultados restauradores.*

Palavras-chave*: Cores dentárias; Seleção de cores; Dentistas Nigéria.*

INTRODUCTION

One of the areas in dentistry that the untrained eye can identify as questionable on a tooth is its shade. It may not necessarily require a beholder to be a specialist to know that the shade of a restoration is incorrect (1). The ability to match the shade of a restoration to that of the natural teeth is an important goal of the dental practitioner especially the restorative dentist. Ideally, when placed in the mouth, the restoration should match the color and shape of the patient's natural dentition. This has been described as the critical final step in aesthetic restorative dentistry once morphology and occlusion are addressed (2).

Color matching is a major factor in determining the quality and success of dental restorative procedures. Selection of tooth shade requires visual comparison between the natural teeth and standard colored dental shades guides by the dentist. The dental shade guide is placed adjacent to the natural tooth that abut the saddle and then a decision is made as to the best dental shade from the shade guide that visually appears to match the natural tooth.

Shade matching is undoubtedly highly technical with unpredictable outcome. It can be improved by an understanding of the variables that influence color perception, such as light source, environment and clinician making the observation (3, 4). Lighting in the dental surgery facilities is possibly the most important factor in proper shade matching. Most of the lights we perceive are reflected and not directed. The color of the light we perceive is that portion of the visible spectrum that is not absorbed by the object. The brain processes light images that are received and allows it to perceive colors and can be deceived into seeing shades differently. Staring at a tooth for more than five seconds will cause incorrect perception of the color because the eyes become accommodated to colors red and yellow. During shade matching, the clinician can avoid eye fatigue by looking occasionally at neutral surfaces or at colors complementary to those prevalent in tooth shades guide, such as blue (4) a concept that has been called retina "cleansing"(5).

Metamerism, a condition in which the color of two objects look identical when observed

under same light source but different under different light conditions can also affect the process of shade matching.

The best light source for shade matching is the natural daylight or light sources that are color corrected with a color temperature of approximately 5500 K and a color-rendering index of 90 or higher (4, 6, 7, 8). Therefore operatory lights should not be used for shade matching. Also, fluorescent bulbs that have not been color corrected will give off a red spectrum and cause a shade to be perceived incorrectly (2). The intensity of the light is also important, extra oral light intensity should be in the range of 200 to 300 foot-candles, with a ratio of intraoral to extra oral illumination of 3 to 5:1 (4).

The color environment of the surgery rooms is also a critical factor which can affect shade matching. Walls and cabinets should be glossy enough to maintain brightness without causing a glare. It is recommended that the color of the walls and ceiling be white or off-white. Anything in the operatory that alters the transmission of light will alter the perception of any color, for example the patient's clothing, makeup, complexion and rubber dam (3, 5).

Research has demonstrated that dental personnel who have impaired color vision make significantly more errors in the process of shade matching. Studies (9, 10) have shown that women generally are more capable than men in the shade selection and color matching process. This may be due to more deficiencies in color vision recorded for men than for women (11). In view of the above, it has been suggested that dentists have a second opinion during the shade selection process (12-14).

Standardized shade guides have been developed to assist in the process of shade selection and to help practitioners communicate effectively with the dental technician. However, the successful use of these shade guides depends on the accuracy of the color assessment by the individual choosing the shade, as well as the effective communication with the dental laboratory. The process of shade selection is an art and selecting the proper shade and matching restorations to the natural dentition have continued to be challenges for the restorative dentist[1]. To date, shade matching practices and patient's complain about shade matching ability of dentists have not been appraised carefully in the dental literature. This study was aimed at providing information on Nigerian experience.

MATERIALS AND METHODS

The data were collected by paper questionnaire mailed at random to the dentists in the dental centers of some Nigerian Teaching Hospitals and State General Hospitals. The questionnaires comprised of two aspects. The first part inquired about their gender, specialty and the number of years of practice. While the second part included involvement in tooth shade matching procedures, whether they select tooth shade alone or in consultation with other colleagues or staff, lightings of the operatory and the frequency at which their patients complained about the tooth shade selected for them. About 95% of the questionnaires were retrieved and analyzed. Statistical analysis was performed using SPSS statistical software (SPSS Inc. 1999). Frequencies cross tabulations and proportions were calculated. Associations between discrete variables were tested with Chi square and Likelihood ratio Chi square. Correlations between discrete variables were tested with spearman rho's correlation. Statistical significance was inferred at $p<0.05$.

RESULTS

One hundred and sixty dentists participated in the study; 83 (51.9%) males and 77 (48.1%) females (Table 1). Age ranged from 21 to 57 years, mean age 32.7 + 6.64 (+ standard deviation). The majority (57.5%) were non-specialized dentists (postgraduate resident doctors and dental interns), while only 42.5% were specialists (Table 2).

TABLE 1 - Mode of selecting tooth shade by sex

Mode of selecting tooth shade	Gender					
	male		female		Total	
	No	%	No	%	No	%
Alone	27	33	26	34	53	33
With others	56	67	51	66	107	67
Total	**83**	**100**	**77**	**100**	**160**	**100**

$X^2=.028$, df=1, p=0.87.

TABLE 2 - Frequency of selecting tooth shade

Specialization	FREQUENCY					
	rarely		often		Total	
	No	%	No	%	No	%
Non specialist	26	16.25	66	41.25	92	57.50
Oral medicine / pathologists	5	3.10	5	3.10	10	6.25
Oral surgeons	7	4.40	17	10.60	24	15.00
Orthodontists	2	1.30	4	2.50	6	3.75
Paedodontists	1	0.60	5	3.10	6	3.75
Periodontologists	3	1.90	0	0.00	3	1.87
Conservative / Prosthodontists	0	0.00	16	10.00	16	10.00
Public Dental health	3	1.90	0	0.00	3	1.87
Total	**46**	**28.75**	**114**	**71.25**	**160**	**100.00**

Among the specialists, oral and maxillofacial surgeons constituted the majority 35.3%, conservative / prosthodontists 23.5%, Oral pathologist / medicine 13.2%, Orthodontists and paedodontists 8.8%. Periodontologists and the Public dental health specialists were 4.4% each. Table II. According to the years of practice, 53.1% had spent 1 to 5 years, 24.4% 6 to 10 years and 22.5% had been practicing for more than 15 years (Table 3).

TABLE 3 - Mode of tooth shade selection according to year of practice

Mode of selecting tooth shade	years of practice									
	5-10		11-15		16-20		>20		Total	
	No	%	No	%	No	%	No	%	No	%
Alone	20	12.45	15	9.40	8	5.00	10	6.25	53	3.10
With others	65	40.60	24	15.00	8	5.00	10	6.25	107	66.90
Total	**85**	**53.10**	**39**	**24.40**	**16**	**10.00**	**20**	**12.50**	**160**	**100.00**

X^2 =8.662, df=3 p=.034. Spearman rho's correlation =-0.2, p=0.03.

114 (71.3%) of the dentists were often involved in tooth shade matching procedures. The specialties found to be mostly involved were the Conservative / prosthodontists (100%), (Table 2).

About their knowledge of shade matching, majority of dentists (67%) believed that the opinion of others should be sought during shade selection while 53 (33%) did not. There was no significant difference between male and female dentists in their beliefs about obtaining a concurrence from others (p>0.05), (Table 1). However, a negatively weak correlation was found when the knowledge of the dentist about the importance of obtaining a second opinion about shade selected was correlated with their year of practice. Those who had practiced for longer years reported that tooth shade could be selected without concurrence from others (Spearman rho's correlation = -0.2, p=0.003) (Table 3).

Majority of the oral and maxillofacial surgeons reported that the concurrence about shade selection is not needed from others (Table 4).

TABLE 4 - Knowledge of tooth shade selection on having second opinion according to specialization

Specialty	mode of tooth shade selection					
	alone		with others		Total	
	No	%	No	%	No	%
Non specialists	27	16.9	65	40.60	92	57.50
Oral medicine / pathology	5	1.30	8	5.00	10	6.25
Oral surgery	14	8.80	10	6.25	24	15.00
Orthodontics	2	1.30	4	2.50	6	3.75
Paedodontics	2	1.30	4	2.50	6	3.75
Periodontology	2	1.30	1	0.63	3	1.90
Public health	0	0.00	3	1.90	3	1.90
Conservative / prosthodontics	4	2.50	12	7.55	14	10.05
Total	**53**	**32.10**	**107**	**66.90**	**160**	**100.00**

However, when asked about the dentists' practice of consulting others before selecting tooth shade in their routine dental practice, only 65 dentists (40.6%) consults with others before selecting tooth shade (Table 5).

TABLE 5 - Practice of Second opinion in shade matching by the years of practice

Practice of consultation at arriving an acceptable tooth shade	**years of practice**									
	1-5		**6-10**		**11-15**		**>15**		**Total**	
	No	%	No	%	No	%	No	%	No	%
Seldom	48	30.0	24	15.0	13	8.10	10	6.25	95	59.4
Often	37	23.1	15	9.40	3	1.90	10	6.25	65	40.6
Total	**85**	**53.1**	**39**	**24.4**	**16**	**10.0**	**20**	**12.5**	**160**	**100.0**

Likelihood ratio $X^2 = 10.998$, df = 10, p = 0.529

Also 136 dentists (85%) believed that tooth selection is best done under natural day light (Table 6a). There was no significant difference between sex, the dentists' age and the years of practice in the knowledge on the optimal lightning condition required for tooth matching procedures (Table 6a). However, majority of the respondents actually performed their teeth shade selection under dental light (Table 6b).

TABLE 6a - Knowledge of the dentists by gender on lightening conditions for shade selection

Lightening conditions	**gender**					
	male		**female**		**Total**	
	No	**%**	**No**	**%**	**No**	**%**
Natural light	69	83.1	67	87.0	136	85
Dental light	4	4.8	3	3.9	7	4.4
Fluorescent	6	7.2	4	5.3	10	6.3
Natural and dental light	3	3.6	1	1.3	4	2.5
Natural and fluorescent light	1	1.3	2	2.5	3	1.9
Total	**83**	**100**	**77**	**100**	**160**	**100**

Likelihood ratio $X^2 = 1.73$ df = 4, p = 0.794.

TABLE 6b - Practice of the dentists by gender on lightening conditions for shade selection

Lightening conditions	**gender**					
	male		**female**		**Total**	
	No	**%**	**No**	**%**	**No**	**%**
Natural light	2	2.40	0	0.00	2	1.25
Dental light	80	96.40	75	97.40	155	96.88
Fluorescent	0	0.00	0	0.00	0	6.30
Natural and dental light	0	0.00	0	0.00	0	0.00
Natural and fluorescent light	1	1.20	2	2.60	3	1.88
Total	**83**	**100**	**77**	**100**	**160**	**100.00**

Eleven respondents reported frequent complaints about shade by their patients. Eight (79.7%) are males while 3 (27.3%) are females (Table 7).

TABLE 7 - Frequency of complaints by Age group and Sex

Age group	gender		FREQUENCY seldom	often	Total
21-30	Male	No	33	2	35
		%	94.5%	5.7%	100
	Female	No	34	2	36
		%	94.5%	5.6%	100
31-40	Male	No	34	4	38
		%	89.5%	10.5%	100
	Female	No	34	1	35
		%	97.1%	2.9%	100
>41	Male	No	8	2	10
		%	80.0%	20.0%	100
	Female	No	6	0	6
		%	100.0%	.0%	100
	Total		**149**	**11**	**160**

11 (5.6%) dentists reported that their patients often complained about the tooth shade selected (Table 8). Of this eleven dentists, 8 (77.8%) of were males while 3 (22.2%) were females. According to age, as the age of the dentist increases there was an increase in patient's dissatisfaction with the shade selected for them. Also according to the year of practice, 4.7% of those who had spent 1 to 5 years, 7.7% of those who had spent 6 to 10 years, 6.2% of 11-15 and 15% of those who had spent 16 years and above in practice reported that their patients often complained.

TABLE 8 - Frequency of complaints about their tooth shade by patient according to years of practice of attending dentists

Frequency of complaint	years of practice 1-5		6-10		11-15		>15		Total	
	No	%	No	%	No	%	No	%	No	%
Seldom	81	50.60	36	22.50	15	9.40	17	10.60	149	93.10
often	4	2.50	3	1.90	1	0.60	3	1.90	11	6.90
Total	**85**	**53.10**	**39**	**24.40**	**16**	**10.00**	**20**	**12.50**	**160**	**100.00**

Likelihood ratio $X^2 = 1.73$ df = 4, p = 0.794.

DISCUSSION

Esthetics has become an important aspect of dentistry. Until about the last two decades, clinicians considered esthetics to be far less important than function, structure and biology (15). Today, however, it could be devastating if a treatment process does not guarantee a good esthetic outcome for the patient.

The shade matching of a restoration is the critical final step in aesthetic restorative dentistry and it is dependent on the knowledge and skill of dental practitioners on shade selection practice. This study is aimed at providing information on this practice among dental surgeons in Nigeria.

All the dental specialties in Nigeria with the exception of public health dentists indicated their involvement in shade matching practices. This revealed that shade matching is not mainly done by the restorative dentists in the country. Thus, it is imperative that there must be a complete understanding of the subject of shade matching by all categories of dental surgeons so as to achieve satisfactory outcome of both prosthetic and restorative treatments.

From our study however, a fair number of Nigerian dentists demonstrated adequate knowledge and skill in shade matching procedure. Visual color matching can be a highly problematic process due to the relatively large number and complexity of factors that determine the human eye's ability to perceive color. This method of color matching is also subjective. Oftentimes when making a visual comparison, what once looked like a positive match

between a dental shade and a natural tooth results in dental prostheses that are noticeably mismatched and unattractive. The end result is that the dentist must eventually find the proper match through a trial and error procedure. The practitioners' years of practice, experience and specialty appeared not to be a factor in making such color discriminations as noted by Barna et al. (13).

Viewing shades in poor quality light will influence how color is perceived thus, quality of light is the most influential factor in shade taking practices. Majority of the respondents in this study performed their shade matching practices under dental light. The best light source for tooth shade taking is natural daylight because it is the closest to emitting the full spectrum of white light. It has been suggested that dentists should therefore use it for shade matching procedures.

Many dental offices have been designed to face the north to enhance the shade matching and tooth selection process. However, daylight is not at a constant throughout the day based on variances in location, time of day, time of year, and atmospheric conditions, too much natural light in the shade-taking area has been deemphasized by several workers who advocated light sources that are color corrected (5, 8, 16) and fluorescent lights which contains a balance of the entire visible spectrum.

Although about 70% of the dentists demonstrated good knowledge about tooth shade selection, however only 40% of the dentists actually performed tooth shade matching with concurrence from others, a practice which has been strongly advised to be jettisoned (5, 12, 13, 14) because of retinal fatigue, color vision deficiencies and effects of environmental colors which have detrimental effects on the out-come of the shade-taking process. This could result in increased patients complaint and clinical hours' loss which may be quite costly to the running of the surgery. Another important finding in this study was the preponderant of males among the respondents that noted that their patients often complained about the shade selected. Women generally are said to be more capable than men in shade selection and color matching process (10). This had been attributed to the prevalence of color vision deficiencies in men (11). However, it is quite difficult to explain our findings along this line until it has been researched into.

The aberrations in shade matching practices found among these respondents appeared to explain the few patients that complained about the shade of their prosthesis.

Dentists have little or no training in vision physiology or color science; comprehensive color training has continued to be a missing part in the dental school curriculum. If any training at all is given in dental school, it is in passing or simplistic and usually consists of presenting an incomplete explanation of three abstract concepts of the Monsell Notation: hue, value and chroma. Also most practitioners have left the issue of shade selection to dental auxiliaries and sometimes to dental students in teaching hospitals.

In an era of growing interest in cosmetic dentistry, there is a need for adequate training and communication for better and more satisfactory results of shade matching. Thus, it is suggested that there should be a review of the dental curriculum of the universities and training institutions.

Granted that biological function of color vision varies between operators, the seemingly unconventional shade matching practices among the respondents requires a continuous education programme where adequate understanding of color science, best practices in shade matching process, and shade systems that cover the color space of natural teeth would be taught. It is our expectation that such will deliver the highest level of dental care which can lead to a higher level of patient satisfaction in our practices. Future study will be an attempt to look at the prevalence of color vision deficiencies among Nigerian dentists and patients' satisfaction with their tooth shade matching abilities.

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