SPECTROPHOTOMETRIC ANALYSIS OF NATURAL TEETH COLOR IN PATIENTS WITH DIFFERENT ORAL HYGIENE HABITS

Julija Zarkova Atanasova[1*], Katerina Zlatanovska[1], Cena Dimova[1], Sanja Naskova[1], Lidija Popovska[2]

[1]Department of Oral and Maxillofacial Surgery and Dental implantology, Faculty of Medical Sciences, "Goce Delcev" University, Krste Misirkov 10-a, 2000 Stip, Macedonia
[2]Faculty of Dentistry, University Ss. Cyril and Methodius, Mother Teresa 17, 1000 Skopje, Macedonia

[*]email: julija.zarkova@ugd.edu.mk

Abstract

The key to keeping a bright, healthy smile and good oral health is to practice proper oral hygiene. The aim of our study was to see the difference between teeth color in patients who have different habits of oral hygiene.

First a questionnaire was filled by the selected patients (N = 235) consisted of a series of questions for the purpose of gathering information about oral hygiene habits. Than the color of their central incisors, was measured with intraoral spectrophotometer Shade-PilotTM (Degu Dent, Germany), in the middle third of the crown and interpreted with shade tabs from three shade guides Vita Classic, Ivoclar Chromascope and Vita 3D Master. For statistical analysis the patients were grouped into three groups according to the answered questions, the first with excellent habits, the second with good and the third group with bad habits in maintaining oral hygiene. Pearson's chi-squared test ($\chi2$) was used as a statistical method for analyzing the difference between groups.

Results showed that different habits of oral hygiene are an important factor form which the teeth shade depends ($p < 0,001$) ($p = 0,000$). The patients with excellent habits have brightest teeth shades and darkest in patients with bad habits. The reason for darker shades in the patient is the accumulated dental plaque in which pigments are trapped and gives the teeth more yellowish and matte appearance.

We concluded that practicing an excellent and good oral hygiene habit like brushing properly and regularly, using mouthwashes and every day flossing can give a whiter and more healthy looking teeth, than others whit bad oral habits. Overall tooth color is very important for good esthetic and confidence in patients.

Keywords: *Tooth color, Shade guides, Spectrophotometer.*

1. Introduction

Beauty is an ideal that is strongly influenced by social trends and media [1, 2]. But, beautiful smiles are strictly defined by: straight teeth without spacing or crowding, no cracked or broken teeth, no gaps or missing teeth, a healthy pink minimal gum line and very little discoloration. So, it's considered that esthetical smile is designed by the four big S's: shape, shade, style and sensation. Today, tooth discoloration is a major oral health concern and has been seen to affect the quality of life of an individual. Proper oral hygiene plays important role in establishing bright and attractive smile as part of good oral and overall health.

Color is a complex physical phenomenon and in order to understand the unique characteristics of natural tooth shade it need to be carefully analysed. Tooth color is influenced by a combination of intrinsic color and the presence of extrinsic stains that may form on the tooth surface [3, 4]. Intrinsic color depends of the light scattering and absorption within and since enamel is relatively translucent, the properties of dentine can play a major role in determining the basic tooth color [5].

Extrinsic stains tend to form in areas of the dentition which are less accessible to tooth brushing and the abrasive action of a toothpaste [6]. The causes of extrinsic staining can be divided into two categories: those compounds which are incorporated into the pellicle and produce a stain as a result of their basic color called direct staining, and those which lead to staining caused by chemical interaction at the tooth surface called indirect staining. Direct extrinsic staining that are related to poor oral care cause brown and black stains on the teeth, because of the trapped pigments in accumulated dental plaque, acquired pellicle, and calculus or food particles [7]. Also pigments can be formed by chromogenic bacteria in dental plaque usually near gingival

margin and usually particular stains are associated with certain mouths, for instance green and orange in children with poor oral hygiene [8].

Since the extrinsic stains are only superficial, these can be thoroughly removed by the abrasive action of a dental prophylaxis [9], and controlled by the regular use of effective toothpaste [10]. There are a number of methods and approaches to successfully improving the color of teeth including: whitening toothpastes, professional cleaning to remove stain and tartar, internal bleaching of non-vital teeth, external bleaching of vital teeth, micro-abrasion of enamel with abrasives and acid, and the placement of crowns and veneers [11-14].

Within the interest of the tooth discolorations the aim of our study was: to see the difference between teeth color in patients who have different habits of oral hygiene, to see their influence on the color parameter like luminosity and chromaticity using the CIE L*, a*, b* color space, and to find the most prevalent shades according to different shade guides. Also we wanted to find if excellent oral care is correlated with a presence of brightest and whitest teeth.

2. Materials and Methods

In this survey 235 patients were carefully chosen according selective criteria. All of them completed a questionnaire consisted of number of questions, with a pre-formulated answers for the purpose of gathering information about their oral hygiene habits (Table1).

Selection criteria were:

a) Inclusion criteria

- Presence of natural permanent maxillary central incisors (left or right).
- Minimal or average tooth inclinations in horizontal or in vertical plane were acceptable as also minimal incisal abrasion or small incisal angle cracks.
- Teeth with small external discoloration.
- Consents from patients for including them in the survey.

b) Exclusion criteria

- Presence of tooth decay.
- Teeth with root canal treatment.
- Teeth with different kind of restavrations, like filings, crowns of veneers.
- Erosions or extreme tooth abrasions.
- Very inclined of rotated teeth in vertical and horisontal plane.
- Teeth with internal discolorations like fluorosis or tetracycline staining.
- Teeth with hypoplasia or dentinogenesis imperfecta.
- Patient who has previosly undertaken teeth bleaching procedure.

Table 1. Questionnaire about oral hygiene habits

Questions	Answers
1) How often do you brush your teeth?	• I don't brush my teeth (1) • One to twice a day (2) • Three or more times a day (3)
2) What kind of toothpaste do you use?	• I don't use toothpaste (0) • Regular, not specific (3) • Strictly indicated for tooth whitening (4)
3) Do you use dental floss?	• No, I have never used one (0) • Yes, sometimes (1) • Yes, regularly every day (4)
4) Do you use mouth rinses?	• No, never (0) • Yes, sometimes (1) • Yes, everyday (3)
5) How often you visit your dentist for professionally cleaning and tooth polishing?	• I have never used this treatment (1) • Sometimes (2) • Regularly, every 6 months (3)

The color of the maxillary central incisors was measured with noncontact surface intraoral spectrophotometer optical geometry 45/0° ShadePilot™ (Degu Dent, Germany) in property of the laboratory for dental research, at the Faculty of Medical sciences at the Goce Delcev University - Shtip (Figure1).

Figure 1. Spectrophotometer ShadePilot™ (Degu Dent, Germany)

Prior every measurement, patient teeth were cleaned only with ordinary pumice and water, and the spectrophotometer was calibrated according to the manual, while the intraoral pieces were changed for every patient. In order to escape technical bias and mistakes the spectrophotometry was conducted by one practitioner with good qualification skills.

The closest match in the middle buccal third of the crown was interpreted with shade tabs from three

shade guides Vita Classic, IvoclarChromascope, and Vita3DMaster. The most prevalent shade was noted as also the color parameters luminosity L* and chromaticity values a* and b*. Patients in relation to answered questions and achieved scores were grouped into three groups, with different habits in maintaining oral hygiene (Table2).

Table 2. Patient groups with different oral hygiene habits

Groups	Hygiene habits
I	bad hygiene habits (0 - 5 points)
II	good habits (6 - 10 points)
III	excellent habits (11 - 16 points)

3. Results and Discussion

3.1 Results

The results from the scores of the answered questions from the questionnaire showed that 20 of patients, or 85% (N = 49) from the evaluated patients were with bad oral hygiene habits, 43 patients, or 83% (N = 103) had good habits and 35 patients, or 32% (N = 83) had excellent habits.

The most prevalent tooth shades according to the Vita classical/Ivoclar Chromascope / Vita 3D master shade guides in the first group with bad oral habits successively were A2/410/3M2. In the second group with good oral habits the most prevalent shades were A2/120/2M2, and in the third group with excellent oral hygiene habits A1/120/1M1. Different habits of oral hygiene are an important factor from which the teeth shade depends. Pearson chi-square statistical test showed that oral hygiene habits influence on the distribution of tooth color according to all three shade guides (Figures 2, 3, and 4).

ANOVA/MANOVA Factorial Anova (F) test revealed that there is a important statistical differences between patients with different oral hygiene habits and the parametar L*(F = 28.29 and p < 0.001(P = 0.000)). As shown in the Firgure 5, the first group of patients had smallest values for L*, folowed by second group and the largest in the third group.

ANOVA/MANOVA Factorial Anova (F) test also revealed that there is an important statistical differences between patients with different oral hygiene habits in the red/green coordinate parameter a* (F = 16.15 p < 0.001 (p = 0.000)). Patients with bad oral hygiene habit have had greatest values for a*, followed by the patient with good habits, and the lowest value in the patients with excellent oral hygiene (Figure 6).

ANOVA/MANOVA Factorial Anova (F) for the yellow/green coordinate parameter b* showed that there is a statistically difference between groups with different
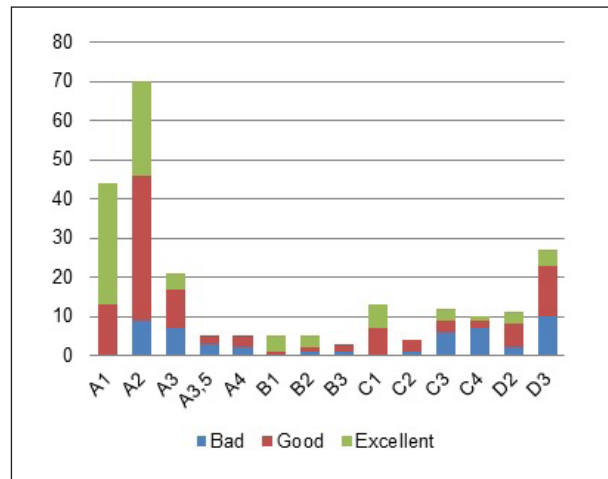

Figure 2. Shade distribution of tooth color according to Vita Classical shade guide
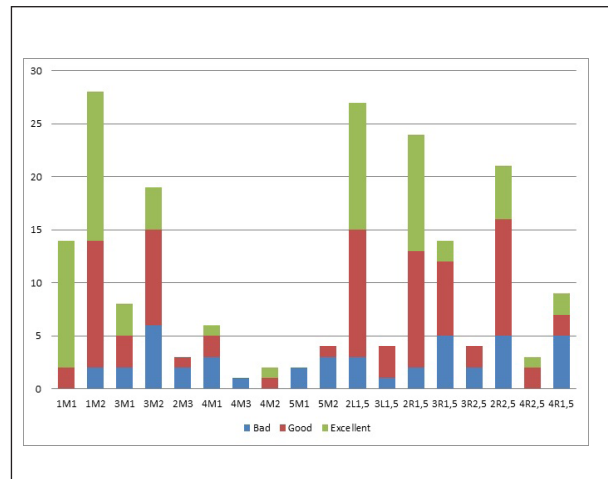**Pearson Chi-square = 83, 29 p < 0.001 (p = 0,000)**

Figure 3. Shade distribution of tooth color according to Ivoclar Crhomascope shade guide
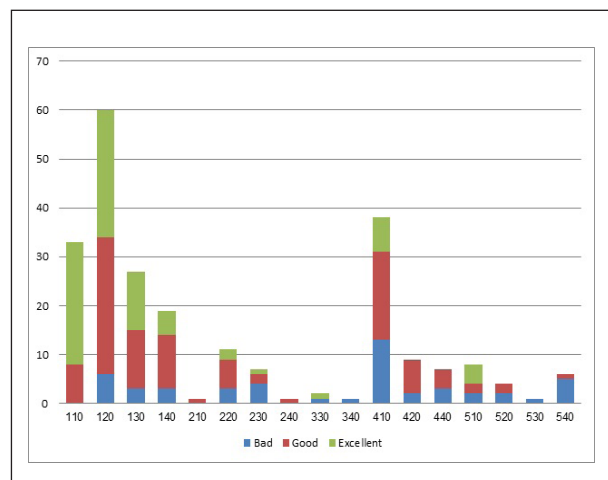**Pearson Chi-square = 87.10 p < 0.001 (p = 0,000)**

Figure 4. Shade distribution of tooth color according to Vita3dMaster shade guide
Pearson Chi-square = 78.24 p < 0.001 (p = 0,000)
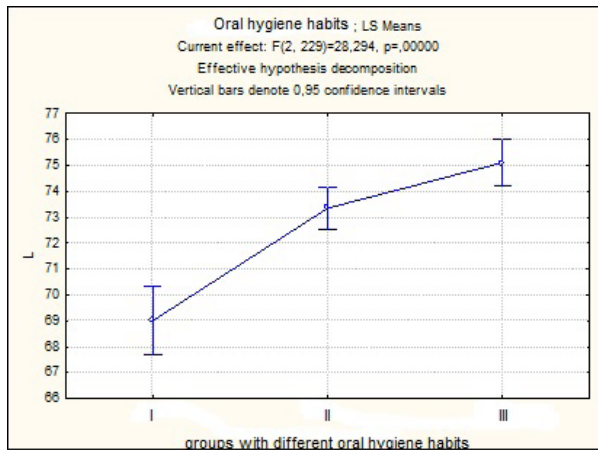
Figure 5. Difference between groups in the parameter L* (lightness)
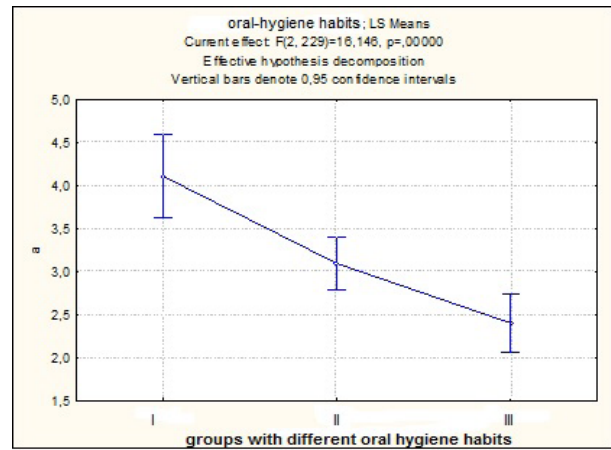

Figure 6. Difference between groups in the parameter a*
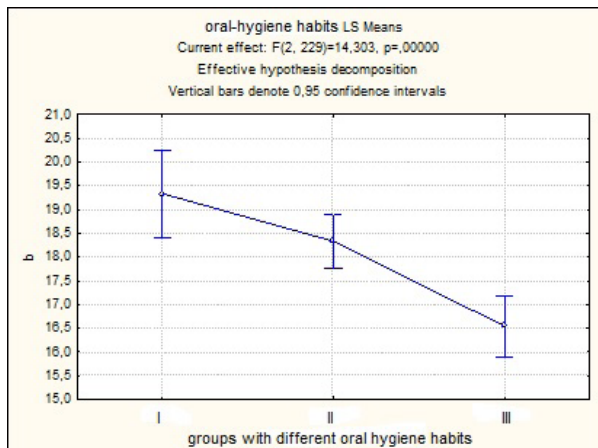

Figure 7. Difference between groups in the parameter b*

oral hygiene habits. The Figure 7 showed that the patients with bad oral hygiene habits have had the greatest values for the parameter b*, followed by the patients with good habits and the lowest in patients with excellent oral hygiene.

3.2 Discussion

In order to have good oral health and strong caries free teeth, oral hygiene needs to be a normal part of our everyday routine. Proper and regular tooth brushing technique, using tooth paste and brush is a necessity for cleaning the dental plaque which is normally formed on our teeth after every meal. Even though dental plaque is a soft, sticky colorless film that builds up on our teeth who contains millions of bacteria, pigments from the food and drinks that we consume, can be trapped inside and cause presence of the plaque to be evident. The formation of dental plaque biofilms includes a series of steps that begins with the initial colonization of the pellicle and ends with the complex formation of a mature biofilm [15, 16]. The pellicle is a thin protein formation on the surface enamel formed by

selective binding of glycoproteins from saliva, seconds after brushing the teeth. In our study the most of the participants had good oral habits 43.83%.

Natural tooth color depends from the intrinsic and extrinsic factors [17]. Intrinsic factors are related with the enamel and dentin characteristics and their interaction with light. Extrinsic factors are directly related with the presence of dental plaque. We found that the oral hygiene habits significantly impact tooth color and its perception. In relation to the three different shade guide which are usually used in every day practice for shade matching we found that when patients have bad oral care darker shade tabs were selected. Because excellent oral hygiene habits ware related with the use of additional products for mechanical plaque control and whitening tooth paste shade tabs from the Vita Clasical, Ivoclar chromacope and Vita3dMaster shade guide were very light shades like A1,120 and 1M1.

CIE Lab color system is used in the dentistry to explain the teeth color quantitative and mathematically [18 - 20]. This tridimensional color space system uses tree coordinates one vertical achromatical axis L* and two horizontal color a* and b* axes. L* or the value or brightness shows how light or dark is the tooth color and a* and b* are showing the basic color of teeth, or is it more in the red/green part of the spectra - axis a* or in yellow/blue - axis b*. In this study we found that the value L* or how light or dark are teeth is influenced by the oral hygiene, and we noticed that patient from the third group with excellent oral hygiene habits has the lightest teeth and the greatest values for L*. Darkest teeth were found in patient with bad oral hygiene with lowest value for L*, followed by the patient with good oral hygiene. We assume that all of this darkening of the teeth in the patient with bad oral habits is related to the present pigments in the unremoved dental plaque which produce direct tooth staining and color changes. Also, mature plaque has active metabolic bacteria that can cause surface demineralization of the enamel

resulting in more matte and blurred appearance of the teeth, lowering their luster and brightness. Direct staining has a multi-factorial etiology with chromogens derived from dietary sources or habitually placed in the mouth. These organic chromogens are taken up by the pellicle and the color imparted is determined by the natural color of the chromogen. Tobacco smoking and chewing are also known to cause staining, as are particular beverages such as tea and coffee, red wine or other tannin-rich foods. The color seen on the tooth is thought to be derived from polyphenolic compounds which provide the color in food [21]. Our results are in relation to the research of Hattab *et al.*, [22] who found that brown stain is thin and bacteria free, and stains most commonly found in individuals with poor oral hygiene due the deposition of tannin found in tea, coffee, and other beverages and in those who use a dentifrice with inadequate cleaning and polishing action.

Toothpastes are thought to be very reliable in reducing or removing the extrinsic dental stains. This can be observed by the increasing number of mouth whitening toothpastes in the market [23]. Considering that the greatest number of teeth external discolorations influence on the value L* resulting in lower brightness of teeth every day usage of whitening toothpastes can make then significantly whither. Whitening tooth pastes are based on formulas that can improve effective mechanical and chemical removing and prevention of surface stains [24].

In this study we found that oral hygiene habits also influenced on the chromaticity of teeth values a* and b*. Bad oral care habits are related with increasing of the parameter a*, and b*. Patients with poor hygiene have redder and yellower teeth compared to patients with good and excellent oral hygiene. Odioso *at al.*, said that the frequency in tooth brushing and in maintaining oral hygiene significantly influence on the parameter L* and b*, which is in correlation with our results [25].

4. Conclusions

- Oral hygiene habits are an important factor for changes in the tooth color. When patients have bad oral hygiene, like using basic products for mechanical plaque control, their teeth become darker, redder and yellower.

- The reason for darker shades in the patient with bad oral hygiene is the accumulated dental plaque in which pigments are trapped and gives the teeth more yellowish and matte appearance.

- Practicing an excellent and good oral hygiene like brushing properly and regularly, using mouthwashes, flossing and regular dentist visits for professional cleaning can give whiter and healthier looking teeth.

- Considering the limitations in our study we can conclude that more studies should be done by combining how dietary factors and oral hygiene factors together influence on tooth color.

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