1st Annual Meeting of the
Society for Color and Appearance in Dentistry
Houston, June 17-18, 2009

ABSTRACTS

1. Spectrophotometric and Spectroradiometric Color of a Shade Guide

Jin-Soo Ahn[1], *Bin Yu*[1], *Jin-Ik Lim*[1], *Yong-Keun Lee*[1]

[1]Department of Dental Biomaterials Science, School of Dentistry, Seoul National University, Seoul, Korea

***Corresponding author*:**

Dr. Jin-Soo Ahn
School of Dentistry, Seoul National University
Department of Dental Biomaterials Science
28 Yeongeon-dong, Jongno-gu
Seoul, 110-749, Korea
Tel: +82 2 740 8693; fax: +82 2 740 8694.
ykleedm@snu.ac.kr

Objectives: Since the color of a shade guide tab is influenced by the surface curvature of tab, colors measured with a spectroradiometer (SR) and a spectrophotometer (SP) are different. Also the influence of light source on the color may vary by the instrument. The objective was to determine the influence of color measurement instrument and light source on the color of shade guide tabs.

Methods: Color of 3D Master shade guide tabs was measured with a SR and a SP. The light sources for the SR measurements were a CIE standard illuminant D65 simulator and an incandescent lamp (A simulator), and those for the SP were the illuminant D65 and A. Differences in color parameters by the instrument and also by the light source were compared. Paired t-test was performed for the difference in color (ΔE^*ab) and color coordinates by the instrument under similar light source or by the light source under the same instrument ($\alpha=0.05$).

Results: The color difference by the instrument under D65 was in the range of 26.6 to 39.3 ΔE^*ab units and the mean difference in lightness (ΔL^*: SP value - SR value) was -29.3 (4.2). The color difference by the instrument under A was in the range of 27.0 to 35.1 ΔE^*ab units. The color difference by the light source was in the range of 2.2 to 10.8 ΔE^*ab units (mean: 4.6±2.1) based on SR measurements, and that for the SP was 0.8 to 3.0 ΔE^*ab units (mean: 1.7±0.5). The influence of light source on color was significantly higher in the SR measurements ($p<0.05$).

Conclusion: Color differences by instrument were very high independent of the light source. Curvature of shade guide tab and measurement protocols obviously influenced the measured color. Standardized measurement protocols should be developed for the spectroradiometric color measurement of curved specimens.

2. Evaluation of individual's matching ability of their own dental shade

Samar Al-Saleh[*1], *Manal Al-Labban*[2], *Morouj Al-Hariri*[3], *Esam Tashkandi*[3]

[1]Department of Prosthetic Dental Sciences, College of Dentistry, KSU, Riyadh, [2]Dental Department, Military Armed Force Hospital**,** KSU, Riyadh, and [3]Department of Prosthetic Dental Sciences, College of Dentistry, Riyadh, KSU

Corresponding author:

Dr. Samar Al-Saleh
Collage of Dentistry
Department of Prosthetic Dental Sciences
King AbdulAziz Road, P.O Box: 88011
Riyadh, 11662, KSU
salsaleh@ksu.edu.sa

Objectives: The purpose of this study was to evaluate the ability of dental students to match the shade of their own teeth.

Methods: Fifty female dental students in the College of Dentistry at King Saud University, who had not received ***any*** formal dental training in color science or shade matching procedures, were screened for color deficiencies and selected to participate in the study. Each subject and three clinicians selected independently the closest match for the subjects' own right or left sound maxillary central incisors under controlled viewing conditions, using Vita classic shade guide.

Each examined central incisor and the 16 samples of Vita classic shade guide were measured with Vita Easy Shade (VES) spectrophotometer to determine the CIELAB color parameters.

The color differences (ΔE) between each examined tooth and the 16 samples of the shade guide were calculated. The minimum ΔE values were compared to ΔE values of the shade obtained by VES, subjects and clinicians**.**

Results: The results showed a significant difference in the accuracy of shade selection between the instrumental and visual means.

ΔE value of shade selected by clinicians was significantly lower than those selected by the subjects**.**

Conclusions: It was concluded that, Spectrophotometric shade analysis was more accurate compared to human shade assessment. Scientific education and prosthetic knowledge of systematic shade selection is valuable in shade selection procedures.

3. **Evaluation of newly developed porcelain color determination system**

Alma Dozic[1]*; Ghazal Khashayar*[1]*; Norbert Voit & Rob Zwartser*[1]*; Jef vd Zel*[1]*; Albert J. Feilzer*[1]

[1]Department of Oral Function and Restorative Dentistry, Academic Centre for Dentistry Amsterdam (ACTA), The Netherlands, Amsterdam

Corresponding author:

Dr. Alma Dozic
Academic Centre for Dentistry Amsterdam (ACTA)
Department of Oral Function and Restorative Dentistry
Louwesweg 1
The Netherlands, 1066EA, Amsterdam
TEL: +31205188237
a.dozic@acta.nl

Objective: The shade tabs of most widely used shade guide for individual color determination of natural dentition (Vita Classical) are randomly distributed within the color range of human teeth. A new patented system was developed based on color shifts from a series of dilution steps with a white color. Using this system it should be possible to obtain color reproduction of the dental restoration by controlling a thickness of the veneer layer. The objective of this study was to evaluate newly developed color determination and reproduction system for use in dentistry.

Methods: Two strongly chromatic dies representing red and yellow porcelain groups were prepared to produce 2 series of 7 colors by augmenting the amount of white in a deliberate mathematical order. Using this method 15 shade tabs, including white, were fabricated. All tabs consisted of dentin base and a translucent porcelain layer. Shade tabs were measured with digital color analyzer, SpectroShade Micro, against black background and the L*a*b* values were analysed using SpectroShade software.

Results: The standard deviations of three measurements for all tabs did not exceed 0.6. The L* shifts of shades ranged from 2-4 ΔL*, the a* shifts from 1-3 Δa* and the b* shifts from 2-4 Δb*. From L*a*b* values color differences (ΔE) were calculated. Average ΔE between two shade tabs were 2.4 (0.5 sd).

Conclusions: 15 shade tabs with equal ΔE shifts between two nearest shades were achieved using dilution method. These tabs can be used not only for color determination but also for color reproduction of layered restorations in computerised dentistry.

4. **In-Vivo Spectrophotometric Match between Teeth and V3DM Shade Guide Tabs**

Tammy Bonstein[1], *Antje Oldenburg*[2]

[1]Department of Restorative, and [2]Freelance Programmer and Statistician, University of Manitoba, Winnipeg, Manitoba, Canada

Corresponding author:

Dr. Tammy Bonstein
University of Manitoba
Department of Restorative Dentistry
D226C-780 Bannatyne Ave.
Winnipeg MB, R3E 0W2, Canada
Tel: (204) 789-3782 Fax: (204) 789-3916
T_bonstein@umanitoba.ca

Objectives: This in vivo study measured the color coordinates (L*,a*,b*) of natural teeth and compared them to Vita 3D Master (V3DM) shade guide tabs. The study aims to determine the frequency of shade tab match to human central incisor color. Moreover, the study aims to determine which shade tabs tested has the closest color coverage to natural teeth color coverage.

Methods: 162 participants age 18 to 70 met the inclusion criteria and entered the study. Participants first brushed their teeth. Oral and soft tissue exam was followed by spectrophotometric measurements of tooth #8, using an intraoral spectrophotometer (Spectroshade, MHT™, Italy). Commission Internationale de l'Eclairage L*a*b* (CIE-L*a*b*) color values of every tooth buccal surface were compared to the V3DM shade tab values programmed in the spectrophotometer software: Vita 3D Master. Delta-E (ΔE) values were obtained using the following equation: ΔE* = [(ΔL*)2 + (Δa*)2 + (Δb*)2] ½. The lowest DE value was recorded for every tooth. Two thresholds were set for color match accuracy: DE>1.0 and DE>3.3.

Results: Out of the 162 teeth 23 teeth had the lowest ΔE with 2M2 shade tab; 18 with 3M2 and 3R1.5; 17 with 2R2.5; 12 with 2R1.5; 11 with 4R1.5; 9 with 4R2.5; 8 with 4M2; 7 with 3R2.5; 6 with 1M2, 3L1.5 and 3M1; 5 with 4M1; 4 with 2L1.5 and 5M1; 2 with 5M2; 1 with 1M1, 2M1, 2M3, 3L2.5, 4L1.5 and 4M3. ΔE>1.0 and for ΔE>3.3., Table-1. Frequency counts of the lowest ΔE match see Figure-1.

Conclusions: Within the parameters of this study closer color matches may be obtained more frequently with V3DM Shade Guide tabs from Family 2 and 3. A look at the 10 most frequent shade tabs indicated the need to increase the redness of the tabs to better fit the color space of natural teeth.

5. **The Importance of self-perceived dental color in a Romanian population**

Diana Dudea[*1], *Horatiu Colosi*[2], *Jean-Francois –Lasserre*[3], *Bogdan Culic*[1], *Camelia Alb*[1].

[1]Department of Dental Propaedeutics, [2]Informatics and Medical Statistics, University of Medicine and Pharmacy Iuliu Hatieganu, Cluj-Napoca, Romania, [3]Department of Prosthodontics, Facultee d'Odontologie "Victor Segalen", Bordeaux 2, France

Corresponding author:

Dr. Diana Dudea,
University of Medicine and Pharmacy
Department of Dental Propaedeutics
Clinicilor Str. No 32
Cluj-Napoca, 400006, Romania
TEL: 0040264592274
e-mail: ddudea@umfcluj.ro

Objectives: 1. To assess the importance attributed by 540 subjects from a Northern-Romanian community to esthetics as a motivating factor in addressing the dental offices

2. To analyze the role played by the dental color among other esthetic parameters in the patients` perception; 3. To analyze the distribution of the subjects according to the self-perception of the dental color

Methods: A multiple-choice questionnaire was distributed to 540 patients who addressed for dental treatment in private dental offices in Cluj-Napoca (Romania); the questionnaire contained questions regarding the most important factors which motivate the visit to the dental office, the importance of the dental shade among other esthetic parameters, the self-perception of the smile; moreover, questions related to the whitening previous experience were asked. The questionnaire was tied to a set of 8 pictures of dental arches divided in 4 groups, based on the dental shade. The patients were asked to self-evaluate their own dental shade and to self-include in one of the groups. Descriptive statistics was performed.

Results: From the 540 patients, 18.4% indicated esthetic problems as the most important motive of their visit into the dental office (as compared with 27.17% which indicated pain, 9.25% limits of the masticatory function, 0.25% speech disabilities, 41.32% regular check-ups and 3.21% other causes). When asked about the most evident defect of their own dental arches, 23% of the patients indicated the dental color (as compared with 34.03% which indicated unaesthetic restorations, 11.79% dental shape, 24.59% lack of dental alignment; 6.65% didn't recognize any esthetic defect). Most of the patients included their dental color into groups II and III (33.7% and 33.89%, respectively); 27.96% indicated group I and 4.44% indicated group IV. Further results including statistic data will be included.

Conclusions: Esthetic problems motivate patients to ask for dental treatment in the questioned group. Dental shade is one of the most indicated defects of the dental arches. Bright and medium shades were indicated more than very bright or dark shades, when patients self assessed their own dental color.

6. **Effects of Specular Component Mode on Color of Resin Composites**

Yumiko Hosoya[1], *Takanobu Shiraishi*[2], *Rade D. Paravina*[3], *John M. Powers*[3]

[1] Department of Pediatric Dentistry and [2]Department of Dental and Biomedical Materials Science, Course of Medical and Dental Science, Nagasaki University Graduate School of Biomedical Sciences, [3] Department of Restorative Dentistry and Biomaterials, University of Texas Dental Branch at Houston, Texas, USA

Corresponding author:

Dr.Yumiko Hosoya
Department of Pediatric Dentistry, Course of Medical and Dental Science
Nagasaki University Graduate School of Biomedical Sciences
1-7-1, Sakamoto, Nagasaki 852-8588, Japan
Tel: +81-95-819-7673, fax: +81-95-819-7676
hosoya@nagasaki-u.ac.jp

Objectives: This study evaluated the effects of the differences in the specular component mode of SCE (specular component excluded) and SCI (specular component included) of a spectrophotometer on color changes of two resin composites after storage of one week and one year.

Methods: Resin composites and shades used in this study were submicron filled Estelite Σ (Σ: Inc, A2, A3, B3, C2, OA2, OA3) and nanofilled Filtek™ Supreme XT (XT: Clear, A2E, A2B, A3B, C2B, A2D, A3D). Resin disks of 2 mm in thickness and final polish with 2,400-grit silicon carbide paper were stored in 100 % relative humidity. One week and one year after curing, the colors of the resin disks were measured with a spectrophotometer in SCI and SCE modes. Data were analyzed using ANOVA and Fisher's PLSD test with α = 0.05.

Results: For both Σ and XT, reflectance of all shades measured with SCI were significantly higher than those measured with SCE at all wavelengths, except for Σ-OA3 and XT-Clear for one-year specimens. For both one-week and one-year specimens, the L* with SCI were significantly higher than SCE for all shades of Σ and XT; however, a* and b* were depended on brands and shades. Comparing one-week and one-year values, ΔE*ab ranged 1.5 (A3 and B3) – 2.9 (Inc) with SCI and 1.4 (A3) – 2.9 (Inc) with SCE for Σ, and 1.1 (A3D) – 7.1 (Clear) with SCI and 1.4 (A3D) – 7.6 (Clear) with SCE for XT. Values of ΔE*ab of SCE were higher than those of SCI for all shades of XT; however, for Σ, the differences were slight and varied with shade.

Conclusions: Color mode (SCE vs. SCI) significantly influenced L* values; however, the color differences affected by storage were depended on brands and shades of the resin composites tested.

7. **Withdrawn**

8. **Color Determination Methods Used by Dutch Dentists: a 5 year study**

Ghazal Khashayar[1]; Alma Dozic*[1], Albert J. Feilzer[1]

[1]Department of Oral Function and Restorative Dentistry, Academic Centre for Dentistry Amsterdam (ACTA), The Netherlands, Amsterdam

Corresponding author:

Dr. Ghazal Khashayar
Academic Centre for Dentistry Amsterdam (ACTA)
Department of Oral Function and Restorative Dentistry
Louwesweg 1
The Netherlands 1066EA, Amsterdam
TEL: +31205188237
G.khashayar@acta.nl

Objective: The objective of this study was to assess and compare the color determination method used by Dutch dentists between 2004 and 2009.

Materials and Methods: This study was carried out by means of a written questionnaire sent to representative groups of Dutch dentists and by means of an interview. The questionnaire (2004) and interview (2009) consisted of 10 questions with various response scales, depending on the variable at stake.

Results: The majority of the dentists in 2004 determined color of anterior teeth visually with Vita Classical (87.9%) whereas in 2009 a visual assessment with this system showed a slight decrease (74.8%) while Vita 3D master system was used more frequently (7% instead of 3%). Visual color determination was found difficult (39.7%) or very difficult (4.5%) in 2004. This percentage increased in 2009 (46.2% and 7%) respectively. The main reason was the inconsistency of the human eye to determine color reproducibly. A large number of Dutch dentists (44.5%) expressed the need to use an electronic system for color measurement although the majority of them reported having no knowledge about electronic systems (38,3%), and only 1.1% of them ever used an electronic system for color determination in 2004. Five years later a significantly higher percentage of dentists had the *knowledge* of electronic systems (56%), yet the usage was not drastically higher (2.1%).

Conclusions: This study showed that Dutch dentists mainly used a visual method for tooth color determination both in 2004 and in 2009. The use of Vita 3D master increased in the last 5 years. A small number of dental professionals used electronic devices for color measurement in 2004 and in 2009, but many of them expressed the need to utilize electronic systems for color determination. Apparently the introduction of diverse color measuring devices in dentistry, which can give more reproducible and precise color data has failed to influence daily clinical practice by Dutch dentists.

9. Colour Variations of a Veneering Ceramic – in vitro

Lehmann K. M.[1], Lopez M.[1], Dietrich H.[1], Scheller H.[1], Götz H.[2], Duschner H[2].*

[1]Department of_Prosthodontics and [2]Institute of Applied Structure- and Microanalysis, University Medical Center of the Johannes Gutenberg-University Mainz, Germany

Corresponding author:

Dr. Karl Martin Lehmann
University Medical Center of the Johannes Gutenberg-University Mainz, Department of Prosthodontics
Augustusplatz 2, Mainz 55131, Germany
TEL: 0049-6131-17-7256 or 0049-6131-17-2211; email lehmann@prothetik.klinik.uni-mainz.de

Objectives: Colour is a key aspect during the production process of esthetically favourable dental prosthesis. Beside form, translucency and colour matching the production of facing is a main aspect. So far veneering ceramics are frequently used. The purpose of this in vitro study was to determine the colour variations of a veneering ceramic under constant test conditions.

Methods: 6 ceramic discs (Vita VM9, Vita Zahnfabrik, Bad Säckingen, Germany) of each of the 17 M colours of the VITA Linearguide 3D Master system were manufactured. L a*b* colour coordinates of each of these discs were measured fivefold spectrophotometrically (Thermo Scientific, Evolution 600 UV-Vis spectrophotometer equipped with an integrating sphere). The colour variations were defined by calculating the colour distances Δ E between the different discs within a series of "identical" colour categories.

Results: The SD within the L a*b* colour coordinates are ≤1. The colour distances Δ E within the different colours are in the range from 0.8 to 3.5 (Table 1).

n	color	mean L	SD L	mean a	SD a	mean b	SD b	Δ E
6	0M1	80.1	0.3	1.0	0.0	4.0	0.1	0.9
6	0M2	77.8	0.4	1.0	0.1	5.7	0.2	1.3
6	0M3	77.8	0.3	1.3	0.1	6.2	0.1	0.9
6	1M1	69.3	0.4	1.6	0.1	7.9	0.2	1.4
6	1M2	71.5	0.5	1.1	0.1	12.9	0.2	1.6
6	2M1	69.0	0.2	1.9	0.1	9.5	0.1	0.8
6	2M2	69.1	0.2	2.8	0.1	14.7	0.3	1.0
6	2M3	70.5	0.5	2.5	1.1	18.0	0.6	1.9
6	3M1	67.3	0.6	2.3	0.1	10.9	0.2	1.4
6	3M2	68.1	0.3	3.2	0.1	14.8	0.6	1.7
6	3M3	67.6	0.3	4.1	0.1	20.8	0.2	1.0
6	4M1	63.5	0.8	2.7	0.1	10.2	0.4	2.2
6	4M2	62.5	0.9	3.9	0.2	16.4	0.6	2.6
6	4M3	64.1	0.5	5.1	0.2	21.3	0.7	2.7
6	5M1	61.2	1.0	3.7	0.1	12.4	0.7	3.1
6	5M2	60.2	0.3	5.0	0.1	17.1	0.3	1.3
6	5M3	61.5	0.8	6.9	0.2	23.5	1.0	3.5

Conclusions: Within the limitations of this in vitro study colour variations within the different colour categories of the VITA Linearguide 3D Master system were detected. Especially, the 4M and 5M colour categories showed predominantly higher Δ E distances. However, the colour variations of the more frequently used colour categories (1M, 2M and 3M) were in a range from 0.8 to 1.9 and clinically acceptable, whereas colour distances ≤1 are not even detectable by human perception.

10. Optical Characterization of Silorane Composite Compared to Universal and Nanocomposites

Maria Del Mar Perez-Gomez[1], Laura Ugarte-Alvan [1], Rade D. Paravina*[2]

[1]Department of Optics, University of Granada, Granada, Spain [2] Department of Restorative Dentistry and Biomaterials, University of Texas Dental Branch at Houston, Texas, USA

Corresponding author:

Dr. Maria Del Mar Per ez-Go mez
University of Granada
Department of Optics
Faculty of Sciences, Campus Fuentenueva
Granada 18071, Spain,
TEL: 0034 958246164, FAX 0034 958243583
mmperez@ugr.es

Objectives: Resin composites are widely used in dentistry. The aim of the current investigation was to make the optical characterization of a new dental composite, Filtek™ Silorane Low Shrink Posterior Restorative, and to compare finding with corresponding data for universal and nanocomposites.

Methods: Six dimethacrylate-composites and one silorane-composite were studied (Shades A2 and A3). Three disc specimens (5mm in diameter and 1.5mm-thick) were prepared for each material. Diffuse reflectance and color of non-polymerized and polymerized composites were measured against white and black background, using a spectroradiometer, and D65 light source (d/0º, 10º standard observer). The CIE L*a*b* color coordinates and translucency parameter (TP) were evaluated separately using one-way ANOVA and Tukey's multiple comparison tests (α=0.05).

Results: There was significant difference (α<0.05) between L*, a*, b* coordinates and between the TP values of non-polymerized silorane composite and dimethacrylate composites. Silorane-based composite showed higher L* and b* values compared to universal composites and nanocomposites. They also exhibited the lowest TP values, because of the pronounced value of diffuse reflectance in medium wavelengths, specially for A2 shade.

For all materials studied, including silorane composite, L* and b* values increased, and a* values decreased after polymerization. Hoverer, the smallest polymerization-dependent difference in color (ΔE^*_{ab}) was recorded for silorane composites, primarily because of the minimal changes in L* values. The silorane composite showed similar tendencies and values of the transparency change, ΔTP.

Conclusions: New dental composite, Filtek™ Silorane Low Shrink Posterior restorative showed better color compared to universal composites and nanocomposites.

11. Development of a Controlled Wavelength Excitation / Fluorescence Spectrometer System

Fred A Rueggeberg[*1], T Smith[2], S Fatehi[1]*

[1]Oral Rehabilitation, Dental Materials Section and [2]General Dentistry, Comprehensive Care The Medical College of Georgia School of Dentistry, Augusta, GA, USA

Corresponding author:

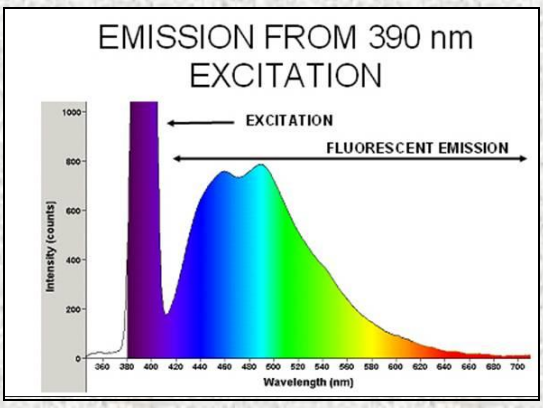
Dr. Fred Rueggeberg
Department of Oral Rehabilitation
School of Dentistry, Room AD-3265A
The Medical College of Georgia
1450 Laney Walker Boulevard
Augusta, GA, 30912-1260, USA
TEL: 706.721.3354, FAX 706.721.8349
frueggeb@mcg.edu

Objectives: To fabricate a fluoresce spectrometer capable of controlling excitation irradiance and wavelength while reading spectral distribution of fluorescence.

Methods: A UV-Halogen excitation source was used. Light output was passed to a computer-controlled attenuation and then segmented into 10nm increments (360–430nm) using narrow bandpass interference filters. A custom-made light bundle was made where a portion of light went to a dedicated spectral radiometer, calibrated for irradiance measurement. The remainder of light was passed through six, 200 micron diameter concentrically arranged fibers, which terminated in a fixed, reflection probe. At the probe end, the excitation fibers symmetrically surrounded a single, central 600 micron diameter fiber, whose output was directed to a separate, dedicated fluorescence spectrometer. At each excitation wavelength, irradiance values were adjusted to the same level. The probe was held 60° from horizontal and pre-polymerized composite specimen was placed directly within the light path. Light reflecting from the composite surface was detected by the fluorescent spectrometer where both the excitation and emitted fluorescent were characterized with respect to diode array count and wavelength.

Results: As excitation wavelength increased from 360 nm, fluorescence rose greatly, peaked at 390nm, after which it decreased greatly at 430nm. Fluorescence was detected throughout the visible spectrum for all excitation wavelengths, but most notably at 460nm and 490nm. Green, yellow , orange, and in some cases, red fluorescence were also identified.

Conclusions: The custom fabricated system operated well, and clearly identified the relative fluorescence intensities within the visible light region with respect to constant irradiance, narrow-band excitation. Results showed that fluorescence in a dental composite occurs even in the absence of "deep UV" radiation, as considerable fluorescence was detected when excitation wavelengths associated with near-UV and visible light were applied: frequencies found in the everyday environment.



12. Split mouth visual and digital color value evaluation of two bleaching systems

Aris-Petros Tripodakis[1], Tanja Karamousli[2], Heracles Goussias[1], Walter. Lueckerath[3], Rade Paravina[4]*

[1] Department of Prostodontics, School of Dentistry, and [2] Donau Universitaet Krems Oesterreich, National and Kapodistrian University of Athens, Greece, [3] Department of Prostodontics, University of Bonn, Germany, [4] Department of Restorative Dentistry and Biomaterials, University of Texas Dental Branch at Houston, Texas, USA

Corresponding author:

Dr. Aris-Petros Tripodakis
National and Kapodistrian University of Athens, Department of Prostodontics, School of Dentistry
92,VAS.Sophias_Ave; Athens 11528, Greece
TEL: +30 210 7752770, FAX +30 210 7473370; email tripod.dental@hotmail .com

Objectives: Vital tooth whitening can be performed either by in-office or at home bleaching. In-office bleaching has been used for many years in dentistry and is known to be a reliable technique for quickly lightening discolored teeth (Faunce, 1983; Jordan & Boksman 1984; Nathanson & Parra, 1987). At-home bleaching also has been shown to produce a significant perceivable change in color, reducing chair time and, therefore, it has become very popular (Jones & others, 1999; Kihn, Barnes & Romberg, 2000; Swift, May & Wilder, 1999).

The purpose of the present study was to clinically evaluate the degree of color change of teeth, associated with in-office and at-home tooth whitening agents.

Methods: Five patients participated in the study after submitting an approved and signed informed consent. A split mouth experimental design was used in applying the two tooth whitening systems in order to compare them simultaneously:

a) The chair side power bleaching system was accomplished by applying 25% hydrogen peroxide gel that was light activated **(Zoom2, Discus Dental)** for 15', three times consecutively on the maxillary left quadrant.

b) The take-home bleaching was accomplished by applying 16% carbamide peroxide whitening gel **(Night White ACP, Discus Dental),** by a custom soft tray on the maxillary right quadrant for 8 hours overnight for 14 days. .

Visual and digital color value analysis methods were used before and after the treatment.

The visual evaluation was accomplished by the **Vita Pan 3D-Master** shade guide using the value scale 0-5.

The digital evaluation of the value changes involved:

a) spectrophotometric measurements by the **Vita Easy Shade** spectrophtometer in the Lab-CIE mode

b) colorimetric measurements before and after the treatment with the **X-Rite Shade Vision System** colorimeter in order to additionally obtain specific color mapping of the bleaching effects.

Results: Visual recordings revealed differences before and after. Both quadrants presented an increase of their value at least of one level. The right side appeared higher in value indicating the higher effectiveness of home bleaching. In the incisal third this difference was even more prominent. Digitally recorded spectrophotometric and colorimetric L values were equally found to be statistically significant before and after in both quadrants and between the left and right quadrant as well. Colorimetric mapping of value changes clearly demonstrated the incisal higher value of the home whitened right quadrant. Meanwhile colorimetric recordings were constantly found to be statistically higher in value than both the spectrophotometric and the visual recordings.

Conclusions: The split mouth clinical comparison of at home and in-office tooth whitening method revealed both visually and digitally that the home procedure was overall more effective. Specific colorimetric mapping evaluation confirmed that the home whitener had a stronger effect in the incisal third, whereas chair side bleaching led to a more homogeneous effect. Moreover it was demonstrated that colorimetric measurements appeared to be clinically less reliable as being constantly higher in value than the spectrophotometric and the visual recordings.

13. Toothguide Trainer tests with color vision deficiency simulation monitor

J. Borbely[1], P. Hermann[1], P. Fejerdy[1], B. Varsanyi[2], H. A. Jakstat[3]*

[1]Department of Prosthodontics, Semmelweis University, Budapest, Hungary, [2]Department of Ophthalmology Semmelweis University, Budapest, Hungary, [3]University of Leipzig, Germany

Corresponding author:

Dr. Judit Borbely
Semmelweis University
Department of Prostodontics
Szentkirályi utca 47
Budapest 1086, Hungary
TEL: +36 20 455-9617, FAX +3613175270
juditborbely@t-online.hu

Objectives: The goal of the investigation was to clarify whether the ability for tooth color differentiation in Toothguide Trainer (TT) tests is limited by color deficient display mode of the monitor.

Methods: 31 dental students after passing Ishihara test participated in the study. A lecture was given on introduction to tooth color differentiation, afterwards a preliminary individual training with the computer program TT was done.

To measure the individual ability of tooth color differentiation in normal and color deficient display modes TT tests were displayed on a calibrated Eizo Flexscan Sx2461W monitor, that served as hardware-based solutions to simulate protanopia and deuteranopia. Record of data was kept on TT tests: 1. normal (Orig) display mode, 2. deuteranotropy simulating (Deut) display mode, 3. protanotropy simulating (Prot) display mode and 4. normal (Orig2) display mode of the monitor.

Data of participants was sent to the central evaluation center at the University of Leipzig. Number of false matching at the Toothguide Trainer as well as the distance between the wrongly determined tooth sample and the correct tooth sample in the L*a*b color scheme was analysed. For statistical evaluation of data Student's t-test was used.

Results: Summation of delta Lab concerning the errors in the three different display modes the numbers were bigger in the colour deficient modes (ΔLabDeut>ΔLabProt>ΔLabOrig>ΔLaborig2). Delta Lab errors were not significantly higher when TT tests were done in deuteranotrop than in protanotrop mode (mean delta LabDeut 52,9 to delta LabProt 49,2). Mean delta Lab lowered significantly (p=0,009) when TT tests were done by the second time in normal display mode (mean delta LabOrig 40,6 to delta LabOrig2 30,3).

Conclusions: Color deficient display mode of the monitor limited the ability for tooth color differentiation in TT test. Tooth color determination in normal display mode of TT test improved by practice.

14. The Screening Capabilities of the Ishihara-Test Using a Data-Projector

Siegfried Bratner[*1], Holger. Jakstat[1], Alessandro Vichi[2], Judit Borbély[3]*

[1]Department of Prosthodontics and Dental Materials, Dental School, University of Leipzig, Germany, [2]Department of Restorative Dentistry, University of Siena, Italy, [3]Department of Prosthodontics, Preclinical and Dental Materials, Semmelweis University of Budapest, Hungary

Corresponding author:

Dr. Siegfried Bratner
University of Leipzig
Department of Prosthodontics and Dental Materials
Nuernberger Str. 57
Leipzig 04103, Germany
TEL: +49 341 9721304, FAX +49 341 9721309
Siegfried.Bratner@medizin.uni-leipzig.de

Objectives: Color deficiency might be a severe drawback when working as a dentist. The most common Deficiency is Red-Green-Color Deficiency. While studying dentistry most Students are not scheduled for such a test on a routine basis. A well known test for Red-Green-Color Deficiency is the Ishihara-Test, presenting printed Tables for testing an individual. The Aim of this study was to determine, if the Ishihara-Test is still a valid Screening Tool, when the color Tables are presented to a bigger group using a common data-projector.

Methods: The Universities of Budapest, Siena and Leipzig participated in the study. 24 Ishihara Tables were presented to a group of 272 Students, 125 (46 %) male and 147 (54 %) female. The age of the Leipzig students was between 19 and 35 years, with an average of 23,2 years for male and 21,9 years for female participants.

Both, automatic and manual evaluation of test-results were used. As „Gold standard“ all participants were also tested using Farnsworth-15-Test, Desaturated-Lanthony-D 15-Test or an Anomaloscope.

Results: Sensitivity of this form of the Ishihara-Test proved to be 100 %, where 14 (11,2 %) of the male participants showed a Red-Green-Color deficiency. Specificity showed to be 99,6 %. The positive predictive value turned out to be 1. No additional test person with Red-Green-Color Deficiency was found with the supplementary tests. The Farnsworth-15-Test proved not to be applicable as a „gold standard“-method, because the sensitivity (compared to the Anomaloscope) was only 21,4 %. It means, that nearly 80 % of the participants with Red-Green-Color Deficiency passed this test.

Conclusions: Showing the Ishihara-Tables with a data-projector seems to be an efficient way to test dental students for Red-Green-Color deficiency. It should be used on a routine basis.

15. A research on fluorescence colorimetry of natural upper permanent anterior teeth

Yan Sun[1]*, Hailan Feng**[1]

[1]Department of Prosthodontics, Peking University School and Hospital of Stomatology , Beijing, China

Corresponding author:

Dr. Hailan Feng
Peking University School and Hospital of Stomatology
Department of Prosthodontics
22# Zhongguancun South Avenue, Haidian District
Beijing 100081, P.R. China
TEL: +861062179977, FAX +861062173402
kqfenghl@bjmu.edu.cn

Objectives: This study is to compare the differences of the fluorescence colorimetry of extracted natural upper permanent anterior teeth in different ages and regions.

Methods: 100 fresh and cleanly extracted upper permanent anterior teeth without any caries and defect were selected for observation. Patients were divided into 5 age groups between 20 to 70 years old, within which 20 samples were selected from each age group. Each sample tooth was then divided into three sections for measurement namely, incisor 1/3, middle 1/3 and cervical 1/3. Each section of the sample was measured three times to obtain an average value. A spectrophotometer with an illuminant of D65 was used to measure the L *, a * and b * values of the different regions of the samples under the ultraviolet and non-ultraviolet modes. The mean number of reflection fluorescence color difference (FL-Ref) was computed under reflection mode, and the fluorescence spectra curve was plotted. The differences of the fluorescence colorimetry related to ages and regions were analyzed and compared using complete randomly designed variance and SNK-q test ($\alpha = 0.05$).

Results: A statistical significance in FL-Ref difference among extracted natural upper anterior teeth in different ages and regions is observed. FL-Ref mean values were different related to ages ($P < 0.05$). By SNK-q examination, 20-29 years old and 30-39 years old age groups showed statistical significance in the differences of FL-Ref value compared with other age groups ($P < 0.05$). On the other hand, no statistical significance is showed among the other age groups ($P > 0.05$); the differences of FL-Ref values between different regions showed statistical significance ($P < 0.05$); According to the fluorescence spectra curve, the fluorescence peak value of natural teeth mainly occurred in the light range of 436nm.

Conclusions: Different fluorescence effects were showed in different ages and regions of extracted natural upper permanent anterior teeth: The FL-Ref increased with age; the cervical 1/3 has the highest reflection fluorescence color difference while that of the middle 1/3 and incisor 1/3 are relatively lower, this result was positively correlated to dental tissue thickness. Clinically, the amount and application of porcelain for fluorescence effect should be adjusted according to the patient's age as well as the distribution characteristic of fluorescence colorimetry of natural teeth.

16. Relationship between tooth color and age – gender - tooth position's: Observational study

Helene Haddad[1], Holger Jakstat*[2]

[1] Department of Prosthodontics, Saint Joseph University, Beirut, Lebanon, [2]Department of Prosthodontics and Dental Materials, Dental School, University of Leipzig, Germany

Corresponding author:

Dr. Helene Haddad
Saint Joseph University
Department of Prosthodontics
Beirut 100081, Lebanon
TEL: 00961 3 85 82 13
helene.haddad@usj.edu.lb

Introduction: Correlation between tooth color and different variables may help achieving natural appearance in esthetic dentistry.

Materials & Methods: 362 natural teeth were randomly selected and classified into 3 age groups for each gender. Teeth colors were measured by a dental spectrophotometer and expressed as L*, a*, and b* (CIELAB color spaces). Correlation, variance F test, Welch's test, and Scheffe's in a post hoc test were performed.

Results: With age, tooth lightness decreased significantly ($p<.0001$) but redness ($p<.0001$) and yellowness ($p<.001$) increased. Lightness was the same for both genders but the men teeth are more reddish ($p=.001$) and yellowish ($p<.001$) than those of women. The anterior teeth of the lower jaw were darker ($p=.017$) than those of maxilla but not statistically different in redness and yellowness.

Conclusion: Described relationships may be useful for tooth color selection in removable and full-mouth reconstructions, for acrylic teeth manufacturing, and personalized shade guides setting-up.

17. Testing and retesting the color differentiation capacity of dental students

Wolfgang.B. Hannak[1], Holger Jakstat*[2]

[1] Department of Prosthodontics, Charité - Universitätsmedizin Berlin, Germany [2]Department of Prosthodontics and Dental Materials, Dental School, University of Leipzig, Germany

Corresponding author:

Dr. Wolfgang Hannak
Charité - Universitätsmedizin
Department of Prosthodontics
Assmannshauser Straße 4-6
Berlin 14197, Germany
TEL: +49(0)30-450-562-714, FAX +49(0)30 -450-562-902
beate.lion@charite.de

Introduction: For some time now, the discussion has focused on whether specific professional groups are better at correctly determining the color of teeth. Several studies on this topic did not arrive at a unanimous result.

Aim of the study: Based on the 3-D Master Color Scale, the Toothguide Trainers (TT) and Toothguide Training Box (TTB) were used to examine whether the capacity for color differentiation is a talent that varies to different degrees.

Material and Methods: Twenty-seven female and 23 male dental students (age range: 20 – 36 years) from the University of Leipzig and Charité-Universitätsmedizin Berlin were included in the study. All participants received the same introduction to TTB after practicing with TT. This was followed by a final exam in which 15 randomized tooth color templates had to be matched. Mistakes were calculated as a scalar at a distance between the position of the templates and the selected color in the LAB color range. Those describing the extent of the mistake are being added and thus represent the capacity to determine the correct tooth color. The smaller the sum, the greater the capacity for color differentiation.

Each participant performed the test three times in one day at 1-hour intervals. Subsequently the intraindividual variation between the 3 test runs and the interindividual variation between all participants was calculated and the statistical significance determined.

Results: The intraindividual variance is clearly lower than the interindividual one (mean value: 110.7 vs. 25.13). Intraindividual and interindividual values were 7.8 and 5.0 with a 95% confidence interval. This difference was significant in the Mann-Whitney test ($p<0.001$).

The participants obtained better results in the re-test than in the test. This difference is significant between the first and the second test run ($p<<0.05$).

Summary: The intraindividual fluctuations of the test results are clearly lower than those among the basic population. Thus it can be assumed that some of the participants have a higher capacity for determining the correct color of teeth. Together with a targeted training, it should therefore be possible to train specialists in this area.

18. Comparing the Accuracy and Popularity of two Shade Guides

*Holger A. Jakstat**[1], *Siegfried R Bratner*

[1]Department of Prosthodontics and Dental Materials, Dental School, University of Leipzig, Germany

Corresponding author:

Dr. Holger A. Jakstat
University of Leipzig
Department of Prosthodontics and Dental Materials
Nuernberger Str. 57
Leipzig 04103, Germany
TEL: +49 341 9721304, FAX +49 341 9721309
Holger.Jakstat@medizin.uni-leipzig.de

Objectives: Working with Shade Guides is a well known practice in Dentistry to determine the right Tooth Shade. The Aim of this study was, to determine which of two Shade Guides (Vita 3D-Master Toothguide and Vita Linearguide will show better results and which Shade Guide will be preferred by the participants.

Methods: Both Shade Guides use the same Template Teeth, but the arrangement follows different designs. 62 Students of the preclinical Department of the Universities Berlin, Greifswald, Olomouc and Leipzig participated in the study. Every participant used both Shade Guides in random sequence. With every Shade Guide 10 randomly presented Template Teeth were determined using a Double blind Design for the Study. For every Tooth deltaLab between the presented and the chosen Template was calculated. The sum of all ten samples was computer for every Shade Guide.
After all Templates we presented a Questionnaire about personal preference. This was completed by every Participant.

Results: Regarding the Questionnaire we could clearly detect two groups: Everyone preferred one of the two Shade Guides. Regarding the accuracy of the Shade Determination both Shade Guides showed nearly similar results (Mean sum delta Lab Linear Guide: 28,18, SD 11,93,Mean sum delta Lab 3-D-Master Toothguide 23,84, SD 13,11, Stud. t-Test p=0,06, non significant).

Conclusions: Using the 3D-Master-Toothguide is best done having knowledge of the optophysical Basics which have resulted in his design. Using the 3D-Master Linearguide is possible on a more intuitive basis. Within the limitation of this study we could show, that both Shade Guides will attract a certain group of users. Thus both can be used in a practical surrounding, where usage will be done on personal preference.

19. The Reproducibility of Spot and Complete-tooth Spectrophotometers for Dental Clinics

Feng Liu *[1], *Mingming Xu*[2], *Tongkai Xu*[3], *Hailan Feng*[3]

[1]Department of Outpatient Centre, [2]Department of Special Dentistry and [3]Department of Prosthodontics, University School and Hospital of Stomatology, Beijing, China

Corresponding author:

Dr. Feng Liu
Peking University School and Hospital of Stomatology
Outpatient Centre
22# Zhongguancun South Avenue, Haidian District
Beijing 100081, P.R. China,
TEL: +861058595045, FAX +861066158520
dentistliufeng@gmail.com

Objectives: The purpose of this study is to compare the reproducibility between spot and complete-tooth spectrophotometers, in order to evaluate the reliability of them for reproduction of tooth shades in dental clinics.

Methods: 31 dental students major in prosthodontics participate in the study. Each of them uses both Vita Easyshade (a spot spectrophotometer) and Olympus Crystaleye (a complete-tooth spectrophotometer) to measure the central region of 8 shade tabs from a Vita 3D-Master shadeguide which are fixed in a dark container. The parameters (L, a, b) of each of the shades measured from the two spectrophotometers are recorded. The average of the parameters (E, E, E, C, C, C) are calculated and used as the "standard parameter" which is the control of the shade tab of this study. The difference between the L,a,b values measured by each spectrophotometer and the "standard parameter" (ΔLE , ΔaE , ΔbE , ΔLC , ΔaC , ΔbC) are then analyzed by pairing T test with SPSS10.0. The difference between ΔEE and ΔEC is also evaluated using the same test. The averages and standard errors of the parameters of all the tabs (SLE, SLC, SaE , SaC , SbE, SbC)are calculated and analyzed by pairing T test to evaluate the total variance of the 2 different type of spectrophotometers.

Results: ΔEE between parameters measured by Easyshade and the "standard parameters" are all lower than 0.6, and ΔEC between parameters measured by Crystaleye and the "standard parameters" are all lower than 1 except for one shade tab. ΔEE of the 8 shade tabs are lower than ΔEC. There are significant differences betweenΔLE1 and ΔLC1, ΔLE2 andΔLC2, ΔLE7 andΔLC7, ΔLE8 andΔLC8, ΔbE7 andΔbC7, ΔbE8 andΔbC8, ΔEE1 andΔEC1, ΔEE2 andΔEC2, ΔEE7 andΔEC7, ΔEE8 andΔEC8 ($P<0.01$). The standard errors of parameters from Easyshade are significantly lower than those from Crystaleye, (SLE and SLC, SaE and SaC , SbE and SbC) ($P<0.01$).

Conclusions: With the limitation of this study, the reproducibility of both spot spectrophotometers and complete-tooth spectrophotometers shows that both spectrophotometers are reliable devices for measurement of tooth shades in dental clinic. However, Easyshade has a higher repeatability than Crystaleye. The spectrophotometers for dental clinics should be used according to the operation criterion for accurate results.

20. Scientific Data Collection Using the Toothguide Trainer Web

Wolf Meerwinck[*1], *Lambert Griep*[1], *Björn Sandkamp*[3], *Lars Wilhelmer*[2]

[1] Department of Software Development, [2]Department of Web Development and [3]Department of Flash Development, SGS Griep Meerwinck GmbH, Hamburg, Germany

Corresponding author:

Dr. Wolf Meerwinck
SGS Griep Meerwinck GmbH
Department of Software Development
Alsterdorferstr. 255
Hamburg 22297, Germany
TEL: 0049 40 500 162 – 0, FAX 0049 40 500 162 – 25
wm@sgs-software.de

Objectives: Toothguide Trainer Web offers a new method of adoption to the so-called "Toothguide Training Box" (a tool for learning color differentiation in dentistry) using an Online Web-Version. The Online Version collects all data for each participant – including the teaching method: the "Linearguide" Method (using the Vita Linearguide 3D Master) or the "Toothguide" Method (using the Vita Toothguide 3D Master). Collecting a large amount of data yields the possibility of statistical analysis.

Methods: Both teaching methods – Linearguide and Toothguide – are implemented in form of interactive flash animations. A separate site offers project registration and initiation: the teacher creates a new scientific project and will get a project-dependent "handle" in form of two alphanumeric codes – one for Toothguide ("Code-T") and one for Linearguide ("Code-L"). Each participant of this project (student) will get one code (Code-T or Code-L), which determines his personal teaching method (Toothguide or Linearguide). All data of participating students for this project are collected by the SQL-Server-Database of the webserver. With the use of the "handle" the teacher has access to "his" data: using the same site as for project creation he can download the collected data for scientific evaluation purpose.

Results: Some examples of projects will be presented in form of anonymised data (format: CSV or XLS / XLM). The content and format of the data will be described.

Conclusion: The Toothguide Trainer Web

- achieves a big amount of participants (students), independent of their personal operation system (Windows, Mac, Unix) and location because of internet access
- implements both teaching methods Linearguide and Toothguide
- allows creation of scientific projects makes the collected data of each project available for scientific evaluation purpose.

21. **Is „Toothguide Checkbox" a useful tool for color differentiation?**

Dana Paulat[*1], *Wolfgang Hannak*[1], *Wolfgand Freesmeyer*[1]

[1]Department of Prosthodontics, Geriatric Dentistry and CMD, Charité Universitätsmedizin, Berlin, Germany

Corresponding author:

Dr. Dana Paulat
Charité - Universitätsmedizin
Department of Prosthodontics, Geriatric Dentistry and CMD
Assmannshauser Straße 4-6
Berlin 14197, Germany
TEL: +49(0)30-450-562-714, FAX +49(0)30 -450-562-902
beate.lion@charite.de

Objectives: Following software program "Toothguide Trainer" (TT) and hardware "Toothguide Trainingbox (TTB), Toothguide Checkbox was designed to complete the learning and teaching concept. Using "Toothguide Checkbox" it is possible to present tooth color differentiation under clinical conditions. By means of PC-aided instruction 3D-master-color scale is designed to distinguish correct tooth color of a pair of incisors made of resin applied in a participant of the study.

Aim of the study: The aim of this study is to find out whether "Toothguide Checkbox" turns out to be an effective and reasonable advancement to its fore runners (TT and TTB), and whether it reveals any didactic success. The comparisons in the results between "Toothguide Trainingbox" and "Toothguide Checkbox" allow to register a scale of points which the participants gained in a test mode.

Material and method: 100 students (68 female and 32 male participants) of Berlin University took part in this study. Probands who were not able to distinguish colors correctly, were excluded beforehand. Subsequently, the participants have to work out "Toothguide Trainer" tests at home at their PC. After that procedure there is a randomisation into study and control group. Both groups pass the training and test program of "Toothguide Trainingbox". The study group deals with the exclusion of the training and test program "Toothguide Checkbox". At that stage, the probands work as a pair, one determining the tooth color of the other one's veneered pair of resin incisors (placed in front of one's own incisors). In this test system the PC serves as a means of randomizer of a pair of incisor veneers, whereas the correct tooth color has been fixed beforehand. The proband will be asked to determine the right tooth color in the training and test mode using VITA 3D master color scale and a standardized source of light. Finally, the participants pass a test mode at the "Toothguide Trainingbox" once again.

Results: Due to the integrated test mode in each program, there is the possibility of having a score of points from each participant in the study. The points reached in the "Toothguide Trainingbox" may hence be compared to the points reached in using "Toothguide Checkbox", resp. the points reached in the second final test using "Toothguide Trainingbox". The results show statistical significant differences. Furthermore, it is possible to filter out how long it took the participant to determine the color correctly, how many errors he made, whether either the female or male participants turned out to be the better detectors, and finally, whether the age of the participant played any role in the whole procedure. The poster will present these results in detail.

Conclusions: "Toothguide Checkbox" presents a sensible upgrading of the teaching concept of "Toothguide Trainer" and "Toothguide Trainingbox" and is able to accomplish a better reference in tooth color determination in the patient.

22. **The Influence of TTB on Shade Matching Accuracy between Standard Color and Intermediate Color**

Mingming Xu[*1], *Feng Liu* [1], *Hailan Feng*[3], *Tongkai Xu*[3]

[1]Department of Special Dentistry, [2]Department of Outpatient Centre, and [3]Department of Prosthodontics, University School and Hospital of Stomatology, Beijing, China

Corresponding author:

Dr. Feng Liu
Peking University School and Hospital of Stomatology
Outpatient Centre
22# Zhongguancun South Avenue, Haidian District
Beijing 100081, P.R. China
TEL: +861058595045, FAX +861066158520
dentistliufeng@gmail.com

Objectives: There are nearly 75% intermediate colors in clinics, which bring dentists much difficulty for shade matching. The aim of the study is to evaluate the influence of toothguide training box (TTB) on shade matching accuracy, and compare the difference between the accuracy of matching standard shade and intermediate shade before and after training with the TTB.

Methods: 31 post-graduate dental students specializing in prosthodontics with 1 to 5 years clinical experience participated in a TTB training session once a week for 3 weeks. All participants are tested negative in color blindness. The elapsed time and scores from each training sessions are recorded each time. The participants are tested before and after the TTB training program and the shade matching results are used to compare the pre-training and post-training shade matching ability of the participants. In the aforementioned test, each participant had to match 7 Standard shade tabs which have been randomly picked out from the Vita 3D-Master shadeguide and 7 Intermediate shade tabs from the Vita 3D-Master bleached shadeguide. SPSS 10.0 software is used in the analysis. The variances of scores and elapsed time are analyses by ANOVA, and the differences of accuracy between standard color and intermediary colors are analyses by Wilcoxon Signed Ranks Test. Pre- and post training shade matching test results.

Results: The scores of the each training session increase with training. There is a significant difference ($P<0.01$) in the scores between the first (900.29±51.68) and the third (933.81±32.94) training session. The elapsed time of each training session decreases with training. A significant difference ($P<0.01$) in the elapsed time is found between the first (46.29±13.29mins) and the second (32.68±8.81mins) training sessions, and also between the first and the third (30.00±7.07mins) training sessions. A significant difference ($P<0.01$) is found in the shade matching accuracy rate between the post-training test and the pre-training test: the general accuracy rate of matching shades are 27.42% before TTB training and 37.1% after TTB training; and the accuracy rate of matching standard shades between the pre-training test and the post-training test are 46.08%±22.04% and 60.37%±18.33% respectively. However, the accuracy rate of matching intermediate color before and after TTB training program did not show a significant difference.

Conclusions: Training with TTB can improve the ability of dental professionals in matching “standard colors” but has minimal influence on improving the ability of matching “intermediate colors”.

23. **Peformance Assessment of Hand-held Shade Matching Lights**

Joe. C. Ontiveros[1,] Craig W. Johnson[2], Ali Obeidi[1], R. D. Paravina[1]*

[1]Department of Restorative Dentistry and Biomaterials, University of Texas Dental Branch, Houston, Texas, USA, [2] School of Health Informatics, University of Texas Health Science Center, Houston, Texas, USA

Corresponding author:

Dr. Joe C. Ontiveros
University of Texas Dental Branch
Department of Restorative Dentistry and Biomaterials
6516 M.D. Anderson, Blvd.
Houston, Texas, 77030, USA
TEL: 713-500-4482, FAX 713-500-4108
joe.c.ontiveros@uth.tmc.edu

Objective: To compare shade matching results obtained using four different dental hand-held lights.

Materials: A total of 92 students were enrolled to perform shade matching and were randomly divided into four hand-held test light groups (Group I–Demetron Shade Light, KerrHawe; Group II–Shade Wand, Authentic Dental Laboratory; Group III–Rite͎lite, Practicon Dental; Group IV–TrueShade, Optident), n=23. Half the students worked with one of the four test lights in the first session and with a professional viewing booth (control) in the second session. The remaining half performed the opposite order. Task tabs were positioned at the upper central incisor socket of a stationary mannequin head while students matched four Vitapan Classical shade tabs–(B1, A2, A3, and A4) using the Linearguide 3D Master shade guide. The time between sessions was 4 weeks. Color difference between the task tabs and all Linearguide 3D Master tabs was calculated. An ordinal score (0=worst, 10=best) was assigned to shade-matching performance. To satisfy distributional assumptions for the extremely skewed ordinal data, SPSS 17 GENLIN Generalized Estimating Equations were employed to test (α=0.05), in a four factor design, whether gender, shade tab, test light, or lighting condition (test light vs. control) affected matching performance.

Results: The median shade-matching score was 9.0 among hand-held light and control groups. Analyses showed no significant main effects for gender, shade tab, test light, and lighting condition, but revealed a significant ($p<0.001$) 4-way interaction. Within groups, only Group III showed no significant ($p<0.05$) main or interaction effects for gender, shade tab, or lighting condition.

Conclusion: Shade-matching performance of hand-held and control lights significantly differed in complex ways depending upon combinations of gender, shade tab, and lighting conditions. Only the RiteLite consistently demonstrated no significant differences compared with the control lighting across all shade tabs and regardless of gender.

24. **Optimization of Dental Shade Guides using Nonlinear Minimization**

Goran Majkic[1], Rade D. Paravina*[2]

[1]Department of Mechanical Engineering, University of Houston, Houston, TX, USA, [2]Department of Restorative Dentistry, University of Texas Dental Branch at Houston, Houston, TX, USA

Corresponding author:

Dr. Goran Majkic
University of Houston
Department of Mechanical Engineering
4800 Calhoun Rd.
Houston, Texas, 77204-4006, USA
TEL: 713 743 8270, FAX 713 743 4503
gmajkic@uh.edu

Objectives: The main objective is to develop a method for optimizing dental shade guides in terms of their color coordinates and as a function of the number of shade guide members, using nonlinear minimization of an objective function, instead of the popular hierarchical clustering method. Also, the goal is to evaluate the performance of nonlinear minimization compared to the clustering method for both adult and primary teeth. Finally, the guides obtained by the two methods are evaluated against another independent sample not used in the development of the shade guide, in order to evaluate the performance of both methods against a random sample.
Methods: A database consisting of L*a*b* color coordinates of 1064 permanent teeth and 612 primary teeth was created using intra-oral spectrophotometer in-vivo. A set of shade guides, with varying number of tabs, was first developed using hierarchical clustering, in order to evaluate the performance of the nonlinear minimization method to the clustering method. The nonlinear minimization was performed by constructing an appropriate objective function to be minimized – in this case the coverage error, and the free parameters were the L*a*b* values of all shade tabs. The nonlinear minimization was then performed by iterative constrained nonlinear minimization. Both CIELAB and CIE2000 color difference formulae were used.
Results: The results indicate that nonlinear minimization consistently provided lower coverage error and more robust behavior when applied to independent samples compared to hierarchical clustering. The same conclusion was found for both CIELAB and CIE2000 color difference metrics. Methods for further improvement of nonlinear minimization using different minimum search methods, as well as constructing different objective functions were discussed.
*Conclusions:*Nonlinear minimization provides a means for developing shade guides for both adult and primary teeth with consistently lower coverage error than hierarchical clustering for both CIELAB and CIEDE2000 formulae.