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ABSTRACTS

Abstract # 1

SPECTROPHOTOMETRIC COLOR CHANGE OF DENTAL SHADE GUIDES AFTER DISINFECTION

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Objectives*:* This study determined whether chemical disinfectants affected the color of porcelain shade guides after disinfection and long-term immersion.

Methods*:* Sixty Vita Lumin shade guides (Vita Zahnfabriek, Bad Sackingen, Germany) for porcelain were used (A3). They were subjected to spectrophotometeric test using the VITA Easyshade (Vident®, Brea, CA) before disinfection (The baseline reading served as control). Disinfection methods included immersion for 10 minutes in 1 of the tested disinfectant solutions; 5.25% sodium hypochlorite (Clorox, Clorox, Oakland, Calif.), 2% alkaline gluteraldehyde (Cidex, Surgikos, Arlington, Texas) or 1.7% trialkyl ammonium propionate (BIB forte, Alpro Medical GMBH, Georgen, Germany). The specimens were cleaned after disinfection; the cleaning methods included ultrasonic cleaning in distilled water for 5 minutes and for 10 minutes, steam cleaning for 30 seconds, and under tap water for 30 seconds (n=5). The disinfection procedures were repeated 4 times and new measurements were made on each specimen after each disinfection cycle. Furthermore, this cycle was repeated after one day of immersion. A random selection of pilot sample of the porcelain shade guide tabs was studied in the same manner and compared to the baseline results. The L*a*b value were recorded and ΔE were calculated. Statistical analysis of data was conducted with repeated measures analysis of variance (ANOVA) and single factor analysis of variance (alpha=.05).

Results*:* All the disinfectant solutions used produced a perceivable change in color ($\Delta E>1$). Immersion time has the most significant effect on ΔE ($P<.001$).

Conclusions*:* There was no preferred cleaning method that has significant reduction in color change. However, tap water and steam were associated with smaller ΔE values. The recommended time of immersion by manufacturer should be followed. Overnight immersion for disinfection should be avoided. Frequent and periodic check up for changes in the color (ΔE) of the shade guides are indicated.

Abstract # 2

THE EFFECT OF ZIRCONIA CORE THICKNESS IN RADIO-OPACITY OF ALL-CERAMICS

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Objectives: The purpose was to investigate the radio-opacity of zirconia core materials with different thicknesses by using digital analysis method.

Methods: Five sample squares (5 x 5 mm) of zirconia cores (Zirconzhan) were prepared according to the manufacturer's instructions with 3 different thicknesses: the test groups consisted of 0.5mm, 0.7mm, and 1.0mm thick materials. All samples were exposed with a 99% pure aluminum (Al) step wedge with ten 1mm incremental steps. On each scanned radiographic image, a 50 x 50 pixel region of interest (ROI) was selected on the center of each test specimen and on each step of the stepwedge. The mean gray values (MGVs) of each sample and Al stepwedge were measured by using the histogram function of a computer graphics program. A total of 75 readings were analyzed with ANOVA and linear regression (with log transformation). P was set as 0.01.

Results: The mean MGVs of aluminum step wedge varied between 20.69 (1mm Al) to 141.94 (10mm Al). All zirconia cores provided higher radio-opacities than the step wedge. The thinnest zirconia cores' (0.5mm) mean MGV was 156.21; the samples with 0.7mm thickness had a mean MGV of 167.87 whereas the thickest samples' (1.0mm) mean MGVS was 178.10. The differences between the MGVs of 3 groups were statistically significant (p=0.000). The Al equivalency was determined using the formula: y= 12.637+54.796ln(x). According to this formula, MGV= 12.637+54.796ln(Al). (r^2=0.995), (p(slope):0.00<0.01)
The radio-opacity of 0.5mm zirconia was equivalent to 13.74mm Al, 0.7mm zirconia was equivalent to 16.996mm Al and 1.0mm zirconia was equivalent to 20.48mm Al.

Conclusions: ANSI/ADA Specification No.27 stated that a 1 mm thick resin-based filling material shall have radio-opacity equivalent to 1 mm of Al, which is approximately equal to 1 mm thick natural tooth dentin. The present investigation revealed that even the thinnest zirconia core was approximately 14 times more radio-opaque than Al, and this finding also related to the radio-opacity of dentine. Since the radio-opacity of the restoration which is made by a very radio-opaque restorative material would prevent the detection of overhangs, recurrent caries, and voids, a material that meets the radio-opacity specifications would be preferable.

Abstract # 3

THE MINIMUM AMOUNT OF SHADE TABS FOR DENTAL COLOR-SPACE COVERAGE

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Objectives*:* The coverage of the dental color-space of 198 teeth with the conventional and the new color determination systems has been assessed with a spectrophotometer. It is defined that the new color-determination and color-reproduction system can provide an excellent coverage of that space with an extended number of tabs. However, for visual color assessment only a reduced number of shade tabs are manageable. The objective was to establish the minimum amount of tabs necessary to cover a vast dental color-space with a precision of $\Delta E \leq 2.7$.

Methods*:* 63 dentists collected the spectral data of 983 teeth using SpectroShade-Micro (MHT, Italy) required for dental restorations. The average L*a*b* values of cervical and body area of each tooth were analyzed by one operator providing the color distribution of 1966 color points. 109 shade tabs of the new system were measured in the two regions providing 218 colors. The total frequency of matching entries ($\Delta E \leq 2.7$) of all teeth colors against each color of the new system and the most frequent incidence of the matching tabs were revealed using Excel software. Less frequent matching entries were omitted in order to obtain practical amount of tabs for visual color determination.

Results*:*

Table1 The Coverage of dental color space with new system utilizing tabs reduction model

area	number of teeth	tabs used	tabs reduction	matches ≤ Δ 2.7	average ΔE	lowest ΔE	highest ΔE	coverage
cervical	983	57	not reduced	808	1.2	0.1	2.6	82.20%
cervical	983	45	single match entries	782	1.0	0.3	1.7	79.55%
cervical	983	33	dual match entries	730	1.2	0.3	2.6	74.26%
cervical	983	28	triple match entries	697	1.1	0.2	2.4	70.91%
body	983	61	non reduced	769	1.0	0.0	2.7	78.23%
body	983	53	single match entries	751	1.1	0.4	2.2	76.40%
body	983	41	dual match entries	699	1.1	0.3	2.7	71.11%
body	983	36	triple match entries	667	1.0	0.4	2.4	67.85%

The most frequent matches for cervical areas were obtained with uA2-2g (9.25%) followed by uA2.5-2g (7.93%), whereas for body areas the most frequent matches were be obtained with the tabs uAB31/1-6g (5.29%) and uAB31/1-4g (4.85%) respectively.

Conclusions*:* 28 and 36 tabs can be used during the visual color assessment for 71% and 68% of body and cervical coverage. However, for more precise color coverage of dental color space the extended color database of the new system, incorporated into a dental spectrophotometer, can be used.

Abstract # 4

IN VIVO COLOR RELATIONSHIPS BETWEEN THE MAXILLARY CENTRAL INCISOR AND CANINE

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Objectives: The objective of this research project is to document the color relationship between maxillary central incisors and canines: (1) whether they share the same hue, but have different chromas (as commonly taught); and, (2) to compare the ΔE values as a function of age.

Methods: Subject receive a 2- tooth polishing using a commercially available prophy paste (maxillary central incisor and canine on the same side) to remove any gross extrinsic staining if they have not just received a full dental prophylaxis by their dental provider. The VITA Easyshade Compact (hand held spectrophotometer) was positioned perpendicular to the tooth being measured and centered on the tooth. Three consecutive measurements were taken for each tooth and an average of the three were used for calculations. The same evaluator performed all measurements. Color differences were calculated using:

a. $\Delta E_{(L^*a^*b^*)} = \{(L^*_1-L^*_2)^2 + (a^*_1-a^*_2)^2 + (b^*_1-b^*_2)^2\}^{1/2}$
b. $\Delta L^* = \Delta L^*_{canine} - \Delta L^*_{central\ incisor}$
c. $\Delta C^*_{ab} = C^*_{ab} - C^*_{ab} = (a^{*2}_{canine} + b^{*2}_{canine})^{1/2} - (a^{*2}_{central} + b^{*2}_{central})^{1/2}$
d. $\Delta H^*_{ab} = [\,(\Delta E_{(a^*b^*)})^2 - (\Delta L^*)^2 - (\Delta C^*_{ab})^2]^{1/2}$

Exclusion criteria:

1. No history of tooth whitening
2. No restorations including facial composites, veneers, crowns or dentures
3. No intrinsic staining present
4. No visible caries or excessive erosion/wear

Results: Preliminary data from 36 patients demonstrate the following trends: (1) ΔE decreases with age primarily due to a increase in chroma for the central incisors; (2) ΔC decreases with age; (3) ΔH decreases with age; (4) ΔL may be increasing slightly with age; (5) Hues, chromas and value of the central and canine are becoming the same with increasing age. For the majority of patients the classical shade tab family (i.e. “A”) for the canine does not predict that of the central incisor.

Conclusions: It appears that the hue of the canine does not predict the hue of the central incisor. Shade selection for older patients should take into account the increasing similarity of canines and centrals.

Abstract # 5

DEVELOPMENT OF A LINEAR MODEL TO PREDICT POLYMERIZATION-DEPENDENT COLOR CHANGES

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Objectives: The purpose of this study was to develop a linear model to predict changes of the CIE L*, a* and b* chromatic coordinates after polymerization for two different types of resin composites.

Methods: Three specimens (5mm in diameter, 2mm thick) of 16 shades of two different commercial resin composites (Artemis – Ivoclar-Vivadent, Schaan, Liechtenstein - and Esthet-X - Dentsply, Milford, DE) were prepared. The reflectance spectra of the specimens were measured three times with a spectroradiometer (SpectraScan PR-704, Photo Research, Chatsworth, CA) both before and after polymerization. The illuminating/viewing configuration was diffuse/0º and a source simulating the CIE-D65 standard illuminant was employed. For each specimen, the CIE L*, a* and b* chromatic coordinates were calculated. The multivariable linear models of statistical inference were determined for each color coordinate, using a standard commercial software (Matlab 7.1, MathWorks, Natick, MA) and employing successive approximations until maximizing the value of r^2.

***Results*:** For the Artemis hybrid resin composite, the linear models which closely predicted the post-polymerization values of each chromatic coordinate were:

$$L^*_{post} = -14{,}2589 + 1{,}1711 \cdot L^*_{pre} + 0{,}2105 \cdot a^*_{pre} - 0{,}0540 \cdot b^*_{pre} \qquad (r^2=0{,}96)$$
$$a^*_{post} = -1{,}5501 + 0{,}0094 \cdot L^*_{pre} + 0{,}7927 \cdot a^*_{pre} + 0{,}0333 \cdot b^*_{pre} \qquad (r^2=0{,}93)$$
$$b^*_{post} = 13{,}9319 - 0{,}1728 \cdot L^*_{pre} + 0{,}4343 \cdot a^*_{pre} + 0{,}9826 \cdot b^*_{pre} \qquad (r^2=0{,}98)$$

For the Esthet-X micro-hybrid dental restorative, the linear models which best predicted the post-polymerization values of each chromatic coordinate were:

$$L^*_{post} = 11{,}6285 + 0{,}8620 \cdot L^*_{pre} - 0{,}0246 \cdot a^*_{pre} - 0{,}0745 \cdot b^*_{pre} \qquad (r^2=0{,}86)$$
$$a^*_{post} = 4{,}6489 - 0{,}0420 \cdot L^*_{pre} + 0{,}9445 \cdot a^*_{pre} - 0{,}0576 \cdot b^*_{pre} \qquad (r^2=0{,}71)$$
$$b^*_{post} = -2{,}4275 - 0{,}0021 \cdot L^*_{pre} + 0{,}0718 \cdot a^*_{pre} + 1{,}0441 \cdot b^*_{pre} \qquad (r^2=0{,}96)$$

***Conclusions*:** Within the limitations of this study, we formulated multivariable linear models of statistical inference, which, starting from the pre-polymerization values of the chromatic coordinates, may estimate the final post-polymerization values of these coordinates. Although the model depends on the type of material, the variation of a color coordinate depends largely on its initial pre-polymerization value.

Abstract # 6

ALL-CERAMIC PARTIAL-COVERAGE RESTORATIONS: EFFECT OF MINIMAL-INVASIVE PREPARATION ON FRACTURE RESISTANCE

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Objectives: To evaluate fatigue behavior and fracture resistance of all-ceramic premolar partial-coverage restorations with different preparation-designs and ceramic thicknesses.

Methods: 144 caries-free natural premolars were devided into 9 groups (n=16). All groups received a MOD occlusal box preparation. Palatal onlay-preparation included the palatal cusp with a reduction of 2mm (Pal.-Onlay-Standard/PO-S), 1mm (Pal.-Onlay-Thin/PO-T) or 0.5mm (Pal.-Onlay-Ultra-Thin/PO-UT), respectively. Full-coverage onlay-preparation included the reduction of the palatal and buccal cusp by 2mm (Onlay-Standard/O-S), 1mm (Onlay-Thin/O-T) or 0.5mm (Onlay-Ultra-Thin/O-UT). Full-veneer preparation was extended to the labial surface with a reduction of 0.8mm (Full-Veneer-Standard/F-S), 0.6mm (Full-Veneer-Thin/F-T) or 0.4mm (Full-Veneer-Ultra-Thin/F-UT). All restorations were fabricated using a pressable lithium-disilicate-ceramic (IPSe.maxPress*, *Ivoclar-Vivadent) and cemented adhesively (Syntac-Classic/Variolink-II*). All specimens were subjected to thermo-cycling (5°/55° C) and simultaneous mechanical loading (F=49N, 1.2x10-6 cycles) in a mouth-motion-simulator (Willytec). After artificial aging restorations were exposed to axial-loading until fracture (Zwick). Mean fracture loads were recorded. Pair-wise differences were calculated and p-values were adjusted by the Tukey–Kramer-Method.

Results: All tested specimens withstood artificial aging. Following mean fracture strength values (N) were recorded: 837 (PO-S), 1055 (PO-T), 1192 (PO-UT), 963 (O-S), 1108 (O-T), 997 (O-UT), 1361 (F-S), 1087 (F-T), 883 (F-UT). Fracture strength values of PO-UT restorations were significantly higher than PO-S values (p:0.01). No differences were observed between O-S, O-T and O-UT. Fracture loads of F-S restorations were significantly higher than F-T (p:0.03) and F-UT (p<.0001).

Conclusions: With application of a pressable lithium-disilicate all-ceramic system a reduction of the preparation depth to 1mm and 0.5mm did not impair fracture resistance of onlay restorations. Irrespective of ceramic thicknesses a beneficial effect of full-coverage of the occlusal surface compared to partial-coverage could not be observed. All investigated restorations revealed loads exceeding physiological mastication forces. However caution is recommended with reduced ceramic thicknesses and application of complex full-veneer preparation designs.

Abstract # 7

INFLUENCE OF BRACKET COLOR FOR DIFFERENT TYPE MALOCCLUSION

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Objectives*:* To examine the influence of bracket color on appearance along with the difference in degree of malocclusion on appearance.

Methods*:* Subjects were students from a dental technician school (17 first and 18 second grades), dental hygienist school (44 first and 46 second grades), and dental school (47 first and 57 sixth grades). Questionnaires were conducted using color photographs of patients wearing three different color brackets (gold, white and silver) in different types of malocclusions: mild malocclusion of anterior teeth without discrepancy (Group A), significant anterior crowding over 4 mm discrepancy (Group B), and significant upper maxillary protraction over 6 mm overjet (Group C). Data were analyzed with a chi-square or Fisher's exact test at $p<0.05$.

Results*:* In each of Group A and C, the most preferred bracket colors were gold (68.6%) and silver (45.7%) for the dental technician school, white (62.2%) and white (61.1%) for the dental hygienist school, and gold (55.8%) and silver (56.7%) for the dental school with significant difference among the schools. In Group B, the most preferred bracket color was white for all schools (77.1% for the dental technician school, 91.2% for the dental hygienist school, and 80.8% for the dental school) without significant difference among the schools. Dental hygienist school students preferred inconspicuous colored brackets. Students from the dental technician school and the school of dentistry showed the highest interest in teeth-alignment, while students from the dental hygienist school had the highest interest in tooth-color and bracket-color.

Conclusion*:* For cases of relatively mild malocclusions of the upper anterior teeth, the most preferable bracket-color varied among the schools. However, for severe cases of malocclusions in the upper anterior teeth, all school students chose the unnoticeable color brackets. Preferable bracket-color depended on the degree and type of malocclusion.

Abstract # 8

EVALUATION OF COLOR DIFFERENCES BETWEEN THREE SHADE MATCHING DEVICES

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Objectives*:* Electronic shade-matching devices may improve the accuracy and reliability of tooth color determination because they are not influenced by illumination or operator variability. Inconsistencies in the color parameters of different devices used by clinicians and technicians, however, can present difficulties. This study evaluated color differences and correlations among the color parameters of three devices (Vita Easyshade/ES, Degudent Shadepilot/SP, X-Rite Shadevision/SV). We tested the null hypothesis that the color differences among devices would be clinically acceptable and would show high linear correlations.

Method*:* Fifteen dental students without restorations, fillings, or irregular surface morphology were enrolled in this *in vivo* study. The color of the four maxillary incisors was measured five times with each device under standardized environmental conditions. A single experienced investigator took all measurements by exactly following the manufacturers' instructions. The color data were generated as CIE L*C*h° values. Color differences were calculated and Pearson's correlation coefficient was used to compare the results among devices.

Results*:* The mean color differences were ES/SP=18,59; ES/SV=23,31; SP/SV=6,23. High linear correlations (>0.7) were found among L*-values and among C*-values of the electronic shade-matching devices. The h°-values showed a low to medium scaled linear correlation (<0.7).

Conclusion*:* Within the limitations of this *in vivo* study, we found clinically unacceptable color differences among spectrophotometers. While the CIE L* and C* color coordinates were highly correlated, the h° coordinates were not. A standardized calibration technique is necessary to reduce the enormous deviations between the CIE L*C*h° coordinates of different devices.

Abstract # 9

IN VITRO EVALUATION OF THE CONSISTENCY AND INTER-CORRELATION OF 3 SPECTROPHOTOMETERS

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Objective*:* Precise information on color is essential in enhancing the esthetic quality of dental restorations. An escalating number of electronically-based devices for tooth color determination are available in the dental market. The objective of this study was to test the accuracy of a new clinical spectrophotometer (CrystalEye - CE, Olympus, Tokyo, Japan) and to compare it to two other known dental spectrophotometers (EasyShade - ES, Vita Zahnfabrik, Bad Säckingen, Germany, and SpectroShade - SS, MHT, S.p.a., Verona, Italy). In order to be able to recommend the use of the CrystalEye we evaluated the ability of this device to consistently repeat the same measurements and how it correlates with the two other previously studied spectrophotometers.

Methods*:* The center of the labial middle third of the 26 shade tabs of a VITAPAN 3D Master (Vita Zahnfabrik, Bad Säckingen, Germany) shade-guide were measured three times at a random sequence with each of the three spectrophotometers. After each measurement the instrument was placed back onto its base, and between each tab the instruments were calibrated according to the manufacturer's instructions. The L*, a* and b* values, as well as the VITA 3D master color-code given by the spectrophotometers, were noted in a form and were input into a SPSS program. Intra-class Correlation Coefficient (I.C.C.) and regression analysis were used to analyze the data. Therefore, for each spectrophotometer, the overall consistency was obtained by computing the average of the consistency measurements for the L*, a*, and b* values separately.

Results*:* The average I.C.C. of the three spectrophotometers ES, SS, CE were 0.992, 0.998 and 0.998, respectively. Although the spectrophotometers gave different results, there were significant correlations between the devices, ranging from 0.986 to 0.999 between their L*, a* and b* values separately.

Conclusion*:* CrystalEye and SpectroShade were found to be equally and highly consistent. Despite the fact that each spectrophotometer differed in absolute L*a*b* values, a significant correlation was found between them. The existing correlation between 3 different spectrophotometers is relevant for dentistry both clinically and scientifically. Based on these results, the new spectrophotometer, CrystalEye was recommended for use in dentistry.

Abstract # 10

PRODUCTION OF COMMERCIALLY UNAVAILABLE COLORS OF DENTIN PORCELAIN MATERIALS

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Objective*:* The prosthetic rehabilitation of anterior teeth often requires the use of materials in colors that are not commercially available. The purpose of this in vitro study was to create commercially unavailable colors of a porcelain restoration material.

Methods: Sixty six porcelain discs (Ceram Kiss dentin material; Degudent GmbH, Hanau, Germany) were manufactured by mixing different proportions of colors A1 and A4. The adjacent L*a*b* color coordinates of each disc were measured five times using a spectrophotometer equipped with an integrated sphere (Thermo Scientific, Evolution 600 UV-Vis). These coordinates were compared using a one-way analysis of variance. The alpha level was set at .05%. Color variations were defined by calculating the mean color distance ΔE between discs.

Results*:* The L* coordinates of nearly all porcelain discs differed significantly, except those with A1:A4 ratios of 30%:70% and 20%:80%. The a* coordinates of all discs also differed significantly. No significant differences were found in the b* coordinates of several disc pairs (A1:A4 = 50%:50% vs. 40%:60%; 30%:70% vs. 20%:80%; 30%:70% vs. 10%:90%; 20%:80% vs. 10%:90%). Similarly, the color distances ΔE between discs of proximate mixing ratios were characterized by lightness values approaching 1.0, except between discs with A1:A4 ratios of 30%:70% and 20%:80%.

Conclusions: Within the limitations of this in vitro study, we successfully used a mixing technique to produce commercially unavailable colors of dentin porcelain materials.

Abstract # 11

USING CIELAB OR CIEDE2000 COLOR-DIFFERENCE FORMULAS IN DENTAL RESEARCH?

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Objectives*:* Limited studies have indicated that an alternative color-difference formula would be more appropriate for use in dentistry. The purpose of this study was to determine which color-difference formula, CIELAB or CIEDE2000, provides a greater degree of fit for judgments of perceptibility and acceptability in dentistry.

Methods*:* A 20-observer panel made independent observations of perceptibility and acceptability judgments on 105 pairs of ceramic disks (14mm diameter, 3mm thick), (VITA Zahnfabrik, Bad Säckingen, Germany). A non-contact SpectraScan PR-704 spectroradiometer (Photo Research, Chatsworth, USA) was used to measure the spectral reflectance of the ceramic disks using diffuse/0º illuminating/measuring geometry . A Verivide CAC60 viewing cabinet (VeriVide Limited, Leicester, United Kingdom) with simulated D65 standard illuminant was employed. The CIE 1931 2º Standard Colorimetric Observer was used to calculate color. The range of the color coordinates of the ceramic disks were L* = 53.95-76.05, a*=0.33-9.94, and b*=4.59-29.75. Color differences of the disks pairs were calculated using ΔE^*_{ab} and ΔE_{00} color-difference formulas. TSK Fuzzy Approximation was used to explore the correlation between the visually perceived and instrumentally measured color differences. Thus, for each pair, the percentage of ΔV answers (% unacceptable or % imperceptible) has been plotted against the instrumentally measured color differences (ΔE_{00} and ΔE^*_{ab}). The coefficient of determination (r^2) was used to compare the two color difference formulas.

Results*:* In the Table are presented the values of r^2 for all fitting curves of the perceptibility and acceptability judgments. It can be seen that when comparing CIEDE2000 with CIELAB, r^2 values are higher for the CIEDE2000 formula.

r^2 values	
Acceptability	**TSK Fuzzy Approximation**
ΔE_{00}	0,89
ΔE^*_{ab}	0,86
Perceptibility	**TSK Fuzzy Approximation**
ΔE_{00}	0,75
ΔE^*_{ab}	0,71

Conclusions*:* The ΔE_{00} color difference formula provides a better fit to the calculated color differences, and therefore its use is recommended in dental research and instrumental color analysis.

Abstract # 12

COLOUR STABILITY OF A COMMERCIAL TEMPORARY RESIN MATERIAL – FIRST RESULTS

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Objectives*:* This in vivo study evaluated the color stability of a commercially available temporary resin material after a 10-day period.

Methods: The temporary resin material (Structur 2 SC; VOCO, Cuxhaven, Germany) was used to manufacture 15 temporary crowns during the prosthetic rehabilitation of 10 patients. The L*a*b* color coordinates of each temporary crowns were spectrophotometrically (Shadepilot; Degudent, Hanau, Germany) measured at baseline and after a mean period of 10 days, whereas the color stability of the temporary resin material was assessed by calculating color distances ΔE.

Results*:* The mean color change of all temporary crowns between baseline and 10 days of clinical use was 3.7 (SD:1.36). The per diem color distance was 0.42 (SD: 0.2).

Conclusions: Within the limitations of this in vitro study, we determined that the mean color distance of temporary crowns fabricated with the resin material used in this study exceeded the clinical threshold (1.0) for acceptable discoloration. The temporary crowns showed unacceptable color changes after approximately 3 days of clinical use. The large standard deviations of the color change values in this study suggest the need for further verification, including evaluation of the effects of colorants such as coffee and tea.

Abstract # 13

RESULTS OF A NEW SCREENING TEST FOR TOOTH COLOR DIFFERENTIATION

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Objectives: Since aesthetic components are becoming increasingly important in the creation of dental reconstructions, the question arises as to which color differences are conspicuous. The aim of this study was to develop a computer program that documents noticeable tooth color differences in a standardized and simple manner.

Methods: The perceptibility of tooth color differences in patients was assessed using a computer program to obtain animated images of the upper and lower front teeth. Participants were asked to identify a tooth with a different shade using the touch screen. The laptop screen was color-calibrated with industrial tools (One Eye, GretaghMacbeth). Using Photoshop all front teeth were punched out, leaving shadows and reflections. With the aid of color-calibrated tooth templates, all teeth were colored to the same value (e.g., 2M1) in the color space of the Vita 3D-Master. One randomly chosen tooth was then colored in a different way (DeltaE between 0 and 16). Participants were asked to identify the altered tooth on 13 consecutive images. This study included 103 participants, 47 men (45.6%) and 56 women (54.4%). There were 12 dentists (11.6%), 47 dentistry students (45.6%), 28 dental technicians (27.2%), 5 dental assistants (4.9%), and 11 patients (10.7%). The majority (i.e., 56) ranged from 19 to 28 years of age.

Results: Altogether 46.1% of the alterations were correctly identified, 37.3% in the upper and 54.6% in the lower jaw. Differences between the initial and the altered color were correctly identified in following percentages of cases:

Color difference (DeltaE)	Correct identification
0.00	38.2%
6.27	17.5%
7.00	42.2%
7.32	1.0%
7.72	52.9%
8.50	36.9%
9.87	84.5%
13.65	92.2%
15.14	83.5%

Conclusion: Noteworthy is the preponderance of correctly identified differences in the lower jaw. Also, in contrast to the literature, the 50/50 decision limit seems to be shifted upward (DeltaE > 6), and the gradient ascent is nonlinear. Side effects through incident light, positioning and reflections appear to be additional decision criteria. Because of these results a new program is created. In this version the randomly chosen tooth is colored in a different way, DeltaE between 0 and 6!

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Abstract # 14

CONSISTENCY OF COLOR MATCHING DEVICES

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Objectives: All-ceramic restorations have become a standard procedure in prosthodontic rehabilitation. Several color-matching devices have been marketed for clinical shade selection and verification of the restoration color prior to final cementation. The purpose of this in vitro study was to compare the color determination differences resulting from using three colorimeters.

Methods: Forty ceramic pressed IPS Empress disks (15.0x0.5 mm) of shades T1 and O2 were luted to 40 composite disks (15.0x4.0 mm) of shades A3 and C4 using yellow-Y shade of Nexus (NX3) resin cement. The specimen combinations were divided into 4 groups (n=5). Color measurement was done using the Vita Easyshade (Vident) and the Minolta Chroma Meter CR-200b colorimeter (Minolta) and the CrystalEye colorimeter (Olympus), configured with diffuse illumination/0º viewing geometry. CIE lightness (L^*), chroma (C_{ab}^*) and hue angle (h_{ab}) values were obtained.

Results: Mean L^*, C_{ab}^*, and h_{ab} are listed below:

Groups (n=5)	**L***			**C_{ab}^***			**h_{ab}**		
	Minolta	*Vita*	*Olympus*	*Minolta*	*Vita*	*Olympus*	*Minolta*	*Vita*	*Olympus*
T1-A3-Y	67.2±0.5	72.3±0.4	68.9±1.3	9.1±0.7	12.3±1.0	15.7±1.7	81.2±1.7	85.8±0.9	72.7±0.3
T1-C4-Y	59.8±0.4	63.1±0.7	58.3±2.1	6.9±0.2	13.3±0.6	10.8±1.8	87.5±0.8	89.9±0.6	78.7±0.8
O2-A3-Y	71.1±0.3	75.0±0.5	70.1±0.9	7.8±0.3	11.8±0.7	13.7±1.1	83.7±1.0	87.7±0.8	72.9±0.4
O2-C4-Y	65.6±0.4	67.6±0.2	61.2±1.9	5.5±0.2	13.1±0.7	9.4±0.6	89.6±1.5	89.9±1.3	80.0±1.1

Four-way ANOVA showed that when all of the three major color directions (L^*, C_{ab}^*, and h_{ab}) were analyzed, each one of the factors studied (ceramic, composite, and color measuring device) was either a statistically significant factor ($P<0.05$) alone or in an interaction with one or more other factors.

Conclusions: Digital color determination may provide an extremely beneficial tool for clinical shade selection, but consistency factors still need to be evaluated.

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Abstract # 15

ANALYSES OF EFFECTS OF PIGMENTS ON MAXILLOFACIAL PROSTHETIC MATERIAL

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Objectives: To investigate the effects of pigments on 1) the cytotoxicity, 2) thermal properties, and 3) the dynamic mechanical properties of pigmented elastomer. Further, an aim is to propose a colorant formulation routine based on this and previous research.

Methods: Unpigmented elastomer (A2000) and elastomer with various pigments (Factor II) were evaluated. Cytotoxicity was assessed by an indirect test for extracts using L929 mouse fibroblasts and a colorimetric assay. For thermal properties, melting temperature (Tm) and change of enthalpies (ΔH) were determined. For dynamic mechanical analysis (DMA), cylinders were subjected to an initial 15% compressive strain before cycling additionally ±10% strain at frequencies from 0.5 to 2.5Hz. ANOVA was used to analyze continuous measurements with subsequent REGWQ pairwise comparisons when indicated.

Results: The unpigmented and pigmented maxillofacial prosthetic elastomers tested demonstrate minor cytotoxicity, with the color indicators for lack of toxicity averaging 91% of the non-toxic control, yet all elastomers were significantly different than the latex (toxic) control (7%). The range of means for Tm were −42.18 to −44.16°C) and for ΔH were 10.70 to 11.86J/g. No significant difference on all the unpigmented and pigmented elastomers was found in Tm and ΔH, except that the Tm of Tan with low concentration (0.1%) (−42.18°C) was significantly lower than that of unpigmented (-44.16°C). DMA showed significant differences in the effects of pigment on storage modulus E’ (P=0.020), and pigment significantly interacted with the frequency for the loss modulus E” (P=0.042).

Conclusions: Although the effect of pigment on the DM properties of maxillofacial elastomer were statistically significant, the cytotoxicity, thermal and DM properties always remained sufficient at the pigment concentrations studied for use in a maxillofacial prosthesis. Colorant formulation using these pigments should be tested for visual accuracy in duplicating the optical properties of various shades of human skin.

Abstract # 16

Evaluation of Translucency of Resin Composites

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Objectives: To evaluate the translucency parameter (TP) of resin composites.

Methods: Disc-shaped specimens (D=10 mm, 2-mm thick, n=5/shade) of A1, A2 and A3 shades were made of the following resin composites: Estelite Σ Quick (ES, Tokuyama), Esthet X HD (EX, Dentsply), Filtek Supreme Plus (FS, 3M ESPE) and Renamel Microfil (RM, Cosmedent). Specimens were polished using PoGo for 40 seconds. Color evaluations were performed by means of spectrophotometer, against white and black background. The data were analyzed by analysis of variance. Tukey post-hoc comparisons of means were calculated at the 0.05 level of significance.

Results: Table. Means (s.d.) of translucency parameter (TP) and background-dependent (black/white) differences in lightness (L*), green-red (a*) and blue-yellow coordinate (b*).

	TP	ΔL^*	Δa^*	Δb^*
ES/A1	8.1(0.7)	5.5(0.6)	1.3(0.1)	5.8(0.4)
ES/A2	7.6(0.7)	4.7(0.5)	1.9(0.1)	5.6(0.5)
ES/A3	5.4(0.6)	2.9(0.4)	1.9(0.1)	4.1(0.5)
EX/A1	6.6(0.3)	4.3(0.3)	1.3(0.0)	4.8(0.2)
EX/A2	7.0(0.9)	4.4(1.1)	1.8(0.2)	5.1(0.4)
EX/A3	7.3(1.0)	4.2(0.7)	2.4(0.1)	5.5(0.7)
FS/A1	7.6(1.4)	4.7(1.1)	1.0(0.1)	6.0(1.0)
FS/A2	6.5(1.1)	3.5(0.7)	1.7(0.1)	5.2(0.9)
FS/A3	6.5(0.5)	3.4(0.3)	2.0(0.1)	5.2(0.4)
RM/A1	7.4(1.2)	4.1(0.8)	2.2(0.1)	5.7(0.9)
RM/A2	8.0(1.0)	4.2(0.7)	2.7(0.1)	6.2(0.8)
RM/A3	8.4(0.3)	4.2(0.2)	3.1(0.1)	6.5(0.2)

Analysis of variance showed significant differences in main effects among materials ($p=0.007$) and significant main effect interactions for materials and shades ($p<0.001$). The L*, a*, b*values were lower against black background (darker, redder and less chromatic). Correlation between TP and L*, a*, and b* coordinates was 0.77, 0.29, and 0.95, respectively.

Conclusion: Values of translucency parameter (TP) were material dependent: Esthet-X HD>Estelite□=Filtek Supreme Plus=Renamel Microfil. The most pronounced change related to translucency was recorded for b* coordinate, followed by changes in coordinates L* and a*.

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