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Comparing the shade matching effectiveness of OMNICHROMA and Filtek Supreme Ultra composites using a spectrophotometer and human evaluators

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Comparing the shade matching effectiveness of OMNICHROMA and Filtek Supreme Ultra composites using a spectrophotometer and human evaluators

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ABSTRACT

Background. The objective of this study was to determine if there were any differences in shade matching ability between a universal shade composite (OMNICHROMA, Tokuyama) and a popular, non-universal shade composite (Filtek Supreme Ultra, 3M ESPE) when measured objectively with a spectrophotometer and subjectively through visual assessment by human evaluators.

Methods. First molar denture teeth in shades A1-4, B1-4 and C1-4 were restored using one of either OMNICHROMA or Filtek Supreme Ultra composite resin in the 'A' shade line, matching the value of the denture tooth being restored. CIE L*a*b* values were collected for the restorations with a VITA Easyshade V spectrophotometer, which were then compared to the shade of the original uncut tooth. Forty-five Billy Johnson Dental Clinic employees were then asked to participate in a subjective evaluation of the filled denture teeth, using a form to give a shade match grade (SMG) for each tooth on a scale from 1-4. Mean difference values were used to evaluate data from both sections of the study.

Results. Nine of the mean difference values for ΔE and ten of the mean difference values for SMG indicated a closer shade match for Filtek Supreme Ultra. Three of the mean difference values for ΔE and two of the mean difference values for SMG indicated a closer shade match for OMNICHROMA.. A closer shade match with ΔE tended to correlate with a closer shade match with SMG. None of the differences in shade matching ability were found to be clinically significant.

Conclusion. No clinically significant difference in shade performance was found. Both composite resins should provide clinically acceptable shade matches.

Key Words. Composite, Universal Shade, OMNCHROMA, Filtek Supreme Ultra

Composite resin has long been used in dentistry as an alternative to amalgam to restore teeth. In recent years, there has been a notable move towards using composite resin and away from using amalgam, particularly after the amalgam phase down provisions made by the 2013 Minamata Convention on Mercury.[1] Other contributing factors to this shift include composite resin's ability to bond to tooth structure, relative ease of repair and conservative preparations. The single biggest factor, however, for the growing preference of composite resin is its ability to provide esthetic, tooth colored restorations.[2]

The shade and color of a composite resin can be broadly defined by its hue, chroma

and value. Hue is the region of the visible spectrum in which the greatest reflection of light occurs. Chroma is the level of saturation of the perceived color. Value is the overall lightness or darkness of a particular shade.[3] Among the three components of shade, value has been shown to be the most important. In addition, the majority of teeth have been shown to skew closer to the Vita Classic A hue than to any of the other three hues. Therefore, even selecting only the proper value of the tooth's shade should result in a close match.[4] In a setting in which it is impractical to keep every shade of composite (e.g. humanitarian missions or military deployments), one possible compromise to save time and space is to stock composite in all different values of the 'A' line of Vita shades.

However, with this method, the shade match result will not be ideal. Dentists will also still need time to determine the proper value of the tooth and multiple different shades of composites to account for the different values available. Furthermore, studies have demonstrated that commercially available resins generally exhibited color differences to standardized Vita Classic Shade tabs and to composites from other brands with identical shade designations.[5, 6] This means that even with all the shades available, additional time may be spent making a subjective decision on which resin to use to match a patient's natural dentition.

In theory, Tokuyama's OMNICHROMA composite could eliminate the need to stock more than one shade of composite and the need to spend time determining shade for individual teeth. According to the manufacturer's technical manual, this universal shade composite is composed of a UDMA and TEGDMA matrix with uniformly sized 260nm spherical SiO2-ZrO2 fillers. As light passes through the OMNICHROMA composite, the size of the fillers allows for generation of a red to yellow color that is combined with light reflected from the surrounding tooth. The uniformity of the spherical filler allows OMNICHROMA to take advantage of the effects of structural color, the phenomenon that occurs when wavelengths of light are affected by the structure of a material itself, to match the reflected natural tooth color.[7]

Previous studies have demonstrated OMNICHROMA composite's color matching abilities when compared to other popular composite resins.[8, 9, 10] However, existing studies either do not compare to composite resins that match the original value of the tooth or do not include a wide range of shades for comparison. Studies are also limited to spectrophotometer data and do not consider whether differences measured in a lab setting are observable in a clinical setting.

The aim of this study was to compare the shade matching ability of OMNICHROMA to that of a popular, non-universal shade composite (Filtek Supreme Ultra, 3M) for 12 of the 16 Vita Classic shades, when using matching values in the 'A' shade for the Filtek Supreme Ultra. A spectrophotometer was used to make objective shade comparison measurements. Human evaluators were then asked to visually assess and report perceivable differences in the shade matching ability between the two composite resins.

MATERIALS AND METHODS

Initial shade measurement and preparation of samples

Ivoclar Vivadent Blueline Lower Denture Teeth (ML6) were obtained in each of the following Vita classic shades: A1, A2, A3, A4, B1, B2, B3, B4, C1, C2, C3, C4. A Vita Easyshade V spectrophotometer was used

against a white background to gather CIE L*a*b* values for both right and left first molars of each shade of denture teeth. Values were collected three times for each tooth to obtain a mean value, with white balancing being completed prior to each new tooth measurement.

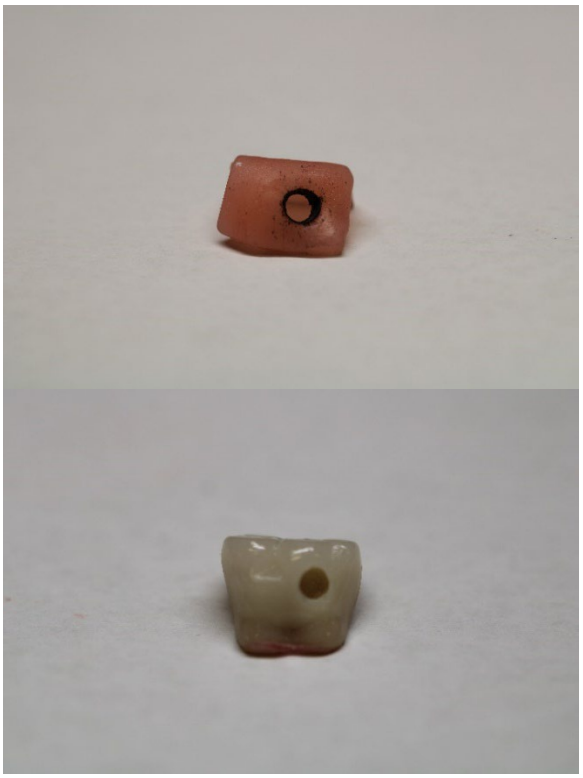

Figure 1. Triad UDMA stencil (above) and prepared first molar tooth (below)

Cavities were prepared on the buccal surfaces of both right and left first molars (four mm diameter x two mm depth), using a 335 dental carbide bur on a water-cooled high speed dental delivery unit. Preparation location and size was standardized through the use of Triad UDMA stencils. The bur was replaced after the preparation of every fourth tooth. For each shade of denture tooth, one first molar was filled with OMNICHROMA and the other with a Filtek Supreme Ultra body composite resin that matched the value of the denture tooth (eg. A1 composite for A1, B1 and C1). Right and left molars were assigned to each resin type in alternating fashion, meaning that each resin was used to restore six right molars and six left molars. A Valo cordless LED curing light was used to polymerize the composites at a distance of approximately two mm with 1000 mW/cm^2 irradiance for 20 seconds. Each restoration was lightly polished using a resin finishing bur (Denstply Sirona Enchance Finishing bur) to remove surface irregularities. The preparation and restoration process was pilot tested with four second molar denture teeth prior to proceeding with first molar samples. No changes were made to the procedure after pilot testing was complete.

Collection of spectrophotometer data

The VITA Easyshade V was used against a white background to obtain reflectance values for each composite resin restoration. L*a*b* values were collected three times for each restoration to obtain a mean value, with white balancing completed prior to each new restoration measurement.

Difference in color between the mean value of each restored test point and its original uncut denture tooth was calculated with a program using the CIEDE2000 color difference equation, which is as follows:

$$\Delta E = [(\Delta L/k_L S_L)^2 + (\Delta C/k_C S_C)^2 + (\Delta H/k_H S_H)^2 + R_T(\Delta C/k_C S_C)(\Delta H/k_H S_H)]^{1/2}$$

Shade comparison by human evaluators

Dental employees from Fort Hood Billy Johnson Dental Clinic (45 total) were asked to participate in the subjective shade-matching comparison portion of the study. For the purposes of this study, dental employees were limited to only include general dentists, dental assistants who have had experience with assisting general

dentists at least within the past two years and dental laboratory technicians.

Each restored first molar denture tooth was assigned a number from 1 to 24 at random and placed in numerical order on a neutral gray background sheet of paper. Participants were asked to observe each tooth and grade the shade match of the restoration to the denture tooth as a whole. Shade match was graded using the following shade match grade (SMG) system: 1. not at all acceptable, 2. marginally acceptable, 3. acceptable, 4. near ideal. To mimic previously documented color science protocols, each participant was asked to take no more than five seconds per tooth and to use a provided neutral gray sheet of paper to reset their eyes between the grading of each tooth.[11] No personally identifiable information was collected other than whether the participant was a dentist or a dental assistant/lab technician.

A condensed pilot version of the survey was completed using four prepared second molar specimens and two dental providers. The pilot survey was completed prior to the preparation of the first molar specimens. Following feedback from the pilot survey, restorative margins for first molar specimens were created to be more discernable, to allow participants to observe the restorations more easily.

Statistical analysis

Due to the limitations of the sample size inherent to the study, analysis of both the spectrophotometer and survey data was solely completed using descriptive mean difference values.
For both ΔE and SMG, the mean difference was calculated as follows:

$$\text{Mean Value}_F - \text{Mean Value}_O = \text{Mean Difference}$$

Mean Value_F = Filtek Supreme Ultra
Mean Value_O = OMNICHROMA

Since a lower ΔE value (objective measurement) would indicate a closer shade match, a negative value for mean difference (ΔE) would indicate a closer shade match for Filtek Supreme Ultra while a positive value would indicate the same for OMNICHROMA. Conversely, since a higher SMG (subjective measurement) would indicate a closer shade match, a positive value for mean difference (SMG) would indicate a closer shade match for Filtek Supreme Ultra while a negative value would indicate the same for OMNICHROMA.

RESULTS

Mean ΔE values for Filtek Supreme Ultra and OMNICHROMA and the corresponding mean differences are found in Figure 2. The smallest mean difference was for the ΔE values of C3 and the largest mean difference was for that of C4. Mean SMG values for the two composite resins and the corresponding mean differences are found in Figure 3. The smallest mean difference was for the SMG of A4 and the largest mean difference was for that of B1.

Mean difference ΔE values were plotted against their corresponding mean difference SMG values in Figure 4. There were two points on the upper right quadrant, indicating a closer ΔE shade match for OMNICHROMA but a closer SMG shade match for Filtek Supreme Ultra. There were eight points on the upper left quadrant, indicating closer ΔE and SMG shade matches for Filtek Supreme Ultra. There was one point on the lower left quadrant,

Shade	Filtek Supreme Ultra	OMNICHROMA	Mean Difference
A1	3.77	4.14	-0.37
A2	4.68	4.17	0.51
A3	4.24	2.78	1.46
A4	4.8	3.57	1.23
B1	5.13	5.49	-0.36
B2	3.54	4.46	-0.92
B3	3.62	4.27	-0.65
B4	3.04	3.8	-0.76
C1	4.13	5.85	-1.72
C2	3.25	5.47	-2.22
C3	4.86	4.91	-0.05
C4	8.52	12.1	-3.58

Figure 2. Mean ΔE values and mean differences

Shade	Filtek Supreme Ultra	OMNICHROMA	Mean Difference
A1	3.45	3.07	0.38
A2	3.19	2.86	0.33
A3	3.52	3.26	0.26
A4	3.26	3.33	-0.07
B1	3.21	2.55	0.66
B2	3.17	2.71	0.46
B3	3.12	2.93	0.19
B4	2.79	3.14	-0.35
C1	3.36	3.02	0.34
C2	3.26	3.00	0.26
C3	3.24	3.10	0.11
C4	3.55	2.93	0.62

Figure 3. Mean SMG values and mean differences

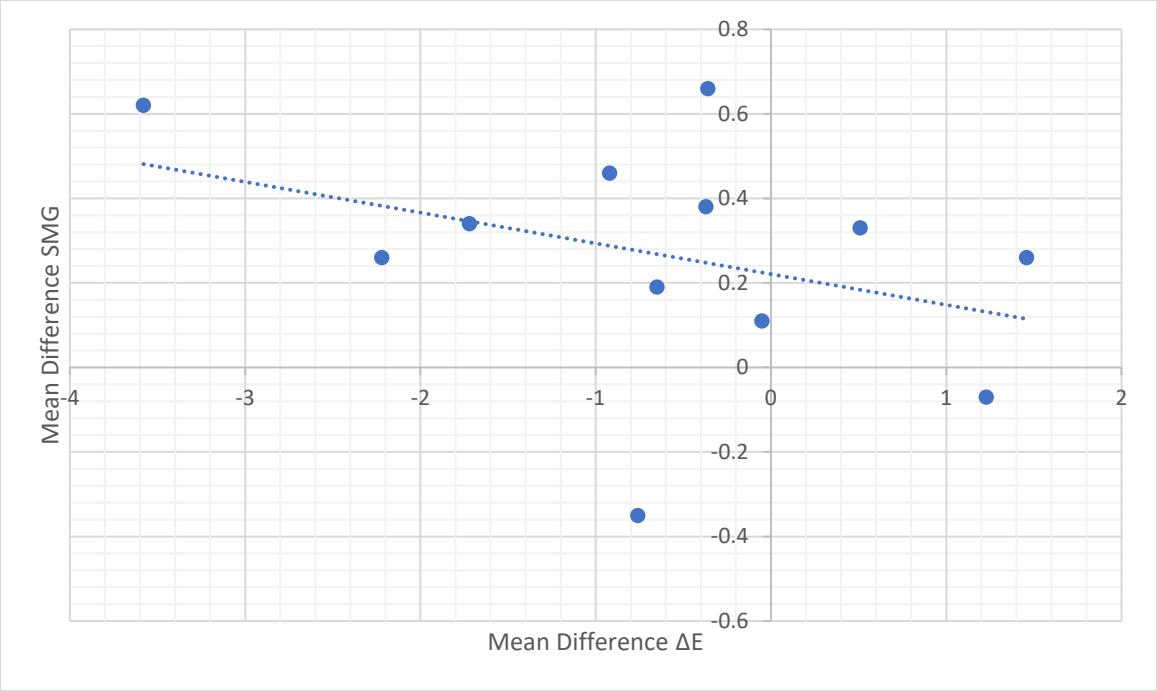

Fig. 4 Mean Difference ΔE vs Mean Difference SMG

indicating a closer ΔE shade match for Filtek Supreme Ultra but a closer SMG shade match for OMNICHROMA. Finally, there was one point on the lower right quadrant, indicating closer ΔE and SMG shade matches for OMNICHROMA. The overall series trendline had a negative slope, with the two most outlying points coming from shades B1 and B4.

DISCUSSION

When looking at the ΔE mean difference values, nine of the mean differences indicated a closer shade match for Filtek Supreme Ultra while the remaining three indicted a closer shade match for OMNICHROMA. The minimal detectable ΔE is 1-2.5, with a commercially acceptable ΔE usually set as 3-6.[12] None of the absolute values of ΔE mean differences were over the commercially acceptable range, with the highest difference coming from that of C4 (3.58). Likewise, when looking at the individual ΔE values, the majority fall within the commercially acceptable range, with the only outliers being the ΔE values of Filtek Supreme Ultra and OMNICHROMA when restoring C4 (8.52 and 12.1, respectively). Ten of the SMG mean differences indicated a closer shade match for Filtek Supreme Ultra while the remaining two indicated a closer shade match for OMNICHROMA. All of the individual mean SMG values were over 2.50, with the majority of values being 3.00 or higher, indicating that all restorations were, on average, deemed to be acceptable. Due to SMG being a grading scale made for the purpose of this study, there are no previous standards that can be used to evaluate against the mean differences. However, it is worth noting that none of the mean differences were greater than a whole point on the SMG scale. The average of the mean differences was 0.27, with only the values for B1 and C4 being greater than even 0.5 points of difference. These results show that although shade match was mostly

closer for Filtek Supreme Ultra than for OMNICHROMA when comparing both ΔE and SMG values, the differences were not beyond what would be clinically acceptable.

The scatterplot of the mean difference values, along with the associated trendline, shows that there is at least some correlation between how the composite resins performed according to ΔE and how they performed according to SMG. Specifically, the negative slope of the line indicates that a closer objective shade match, as obtained by ΔE, tended to correlate to a closer subjective shade match, as obtained by SMG.

An inherent weakness of this study is in the limited amount of data and a corresponding inability to perform proper statistical analysis to account for its power, or lack thereof. Future studies could aim to compare multiple commercially available conventional or universal shade composite resins to OMNICHROMA and to increase the number of participants in the subjective survey. Further studies could also aim to expand on this study by incorporating other classes of restorations beyond the buccal Class V type.

One potential confounding factor that could have affected the results is that the OMNICHROMA composite resin is noticeably more translucent compared to that of the Filtek Supreme Ultra body composite resin and the Blueline denture teeth that were restored. It is possible that this difference in translucency could have been perceived as a difference in shade by some of the survey participants, leading to the differences in SMG values between the two composite resins. Another potential confounding factor could be that because the margins of the restorations were prepared to be visible, due to the results of the initial pilot study, participants may have concentrated on the obvious restorative margin, rather than the shade of the composite resin. Further studies may consider keeping restorative margins well blended but increasing the time given to determine the SMG in order to compensate for the time it may require to locate the restoration. However, one should keep in mind that this will lead to a compromise in regards to the ideal time for shade matching, as determined by previous studies.

Clinically, the results obtained from the study indicate that both OMNICHROMA resin composite and ‘A’ shade Filtek Supreme Ultimate resin composite in the same value as the desired shade provide acceptable restorations in regards to shade match. Based on the findings of this study, due to OMNICHROMA resin’s overall lower scores in both ΔE and SMG values, Filtek Supreme Ultimate resin, if available, should be the primary choice in highly esthetic, anterior teeth cases. However, since using Filtek Supreme Ultimate resin would still require a step to obtain the shade of the tooth, OMNICHROMA resin could the simpler, clinically acceptable shade matchiung option when dealing with posterior restorations. Dental providers who are limited in storage space and looking to reduce overhead and waste, such as deployed military dentists or dentists working service trips in austere environments, should consider stocking a universal shade composite.

CONCLUSION

Within the limitations of this in vitro study, it can be concluded that both Filtek Supreme Ultra and OMNICHROMA composite resin provide clinically acceptable restorations with regards to shade match and that there is no clinically significant difference in shade matching ability when comparing ΔE and

SMG values. It would be beneficial to expand this study by including other commercially available types of composite, especially other universal shade composite resins, and observing shade matching performance when used in other classes of restorations.

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