Introduction

As a dental technician for over two decades, a large amount of my time and energy has been concentrated on the sometimes difficult shade matching process. With a large variety of ages in my patient base, I have been asked to work with many types of colors and characteristics over the years. Numerous times, even with the best of intentions on my part, the final restoration has not matched and has needed adjustment or repair. Through this experience, I have learned valuable lessons about a variety of dentin and translucency colors.1, 2

Every technician has their own concept about color matching. By relating some of my own experiences in this commentary, I hope to help others in the industry so that my mistakes are not repeated.3, 4

There are many characteristics which we consider when matching a patient’s color but often we don’t have the tools to effectively communicate what we observe. My own experience has been one of frustration with the tools that have been available to me which is why I invented my own Chair Side Shade Selection Guide. I have improved communication between myself, the patients and the clinicians with whom I am associated through this detailed guide.

There are certain things I look for, step-by-step, in the shade matching process:

- Enamel overlay and translucency color all the way to the gingival area, noting especially how thick the effect is inside the dentin color. The value and chroma must also be noted – high, low, how different? With a traditional shade guide, the technician will not be able
to accurately account for this information which means he will need to record it separately.

- Hydration vs. dehydration stages. My method of shade taking dictates that I have to have a strategy for dealing with these stages beforehand. Too many times, I have seen a patient become dehydrated before I was able to accurately note color, translucency and mamelon.5

Custom shading is a science, as any technician can tell you. Achieving the delicate balance of enamel overlay, translucency or transparency and surface texture in the incisal, gingival or body 1/3 as well as the mesial and distal areas requires a skill and artistry level that even the most experienced of technicians may have a hard time mastering.

We really only have about 2-5 minutes of time to match a patient’s color. Once a patient’s mouth has been opening and closing beyond that period of time, we will see a difference in the color and translucency of the teeth due to dehydration.6,7 It’s absolutely essential to factor that possibility into the equation when we are making a note of the patient’s custom color.

Because of this potential, we have to check the patient’s saliva level at all times by opening his lips and frequently examining for hydration. Translucency and transparency enamel modifications all depend on the colors we apply - whether they are white, clear, blue, reddish-orange or pinkish-gray; the fact is that without saliva, we won’t know which colors to apply or where to apply them.

In considering these modifications, here is what we need to make a note of:

In which area is that particular color? Is it the incisal, distal, mesial 1/3, body or gingival? Remember, we will overlay with either clear or white enamel effective toward the body and gingival level underneath or over the top to create different colors. We have to consider how thick, dark and strong we want the translucency and transparency application to be but also remember that a thicker one will create a grayish hue to the final color.

The next step should be to consider mamelon and halo, something that cannot be seen without hydration.8 If the patient has a lot of translucency, crack lines that are orange and yellow ochre in color will also appear.

What color is the incisal 1/3? Bright dentin will be covered with clear or enamel color. The differences will be delineated with staining in the gingival, mesial or distal area: orange, ochre, brown-pink or grey.

After we verify all of these modifications, we should next check the patient’s mouth after it is opened for about 20 seconds. Watch the saliva disappear and see the subtle white spots. Translucency creates a dark crack line effect but if we observe high density enamel, we will see white crack lines instead.9,10

Modifications

What about surface texture? Surface texture lines relate to lobe and tooth contour and will have an effect on the final shade the technician chooses. If surface texture doesn’t match with adjacent teeth, the restoration won’t match because the angles and reflection will totally change the color.11,12

In the LSK Chair Side Shade Selection Guide there are a total of six Anterior Surface Textures from which to choose: Dull, Rough, Shiny, Horizontal Wave, Vertical or Natural. Based on years of research, these textures are real and can be recreated if the proper porcelain techniques are used.13
Fig. 1: In the hydration stage, in the mouth, translucency, transparency, mamelon and the amount of enamel overlay was checked.

Fig. 2: After the mouth is open for more than 10 seconds, dehydration will begin to set in. During this stage, with the temporary in the mouth, we can still see the color of tooth #8, but not the translucency.

Fig. 3: Using the LSK Chair Side Shade Selection Guide, a mamelon check was performed.

Fig. 4: The mamelon color for this case was noted to be somewhere between beige and orange, with a blue tint to the incisal 1/3. The final choice, MA-4 or Clear Orange, is one of eight choices the Chair Side Shade Selection Guide offers.

Fig. 5: In a lab test to utilize dentin colors, white, light blue, clear, grey and orange enamel modifications were applied to three sample crowns in order to create different aspects of mamelon for the Chair Side Shade Selection Guide.

Fig. 6: GC Initial Porcelain clear fluorescent was applied with facial glazing to create a different characteristic for each crown. Technicians do this type of work on a daily basis, depending on individual situations.
Fig. 7: Using different enamel modifications and enamel translucency through porcelain layering techniques, the photographed samples demonstrate diverse aspects of internal color modifications. These are three of the one hundred fifty samples created for the Chair Side Shade Selection Guide.

Fig. 8: After the crown for central tooth #9 was fabricated using GC Press material, the same patient as in photograph #4 (above) receives her crown as a try-in, with the same value, translucency and texture as her natural tooth #8.

Fig. 9: Post-cementation, the crown is a perfect match.

Fig. 10: During the hydration stage, a translucency and mamelon enamel overlay check is performed, looking carefully for the degree of color value to apply.

Fig. 11: After the crown is cemented, with hydration, the restoration’s color value and translucency are a match.

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Fig. 12: The Chair Side Shade Selection Guide is used to check decalcification while the patient is hydrated. The important distinction is where will it be added? To the incisal? All over? Incisal and body? This photographed patient has decalcification, or anterior stain, in the Incisal and Body Area, a code of AS-2.

Fig. 13: Next, we have a patient with a similar appearance but this time the staining is defined as AS-3, or All Over. This will require a different sort of enamel modification in order to match with the patient's adjacent teeth. The technician has to have a good grasp of custom shading in order to capture the proper amount of staining he will apply.

Fig. 14: The Chair Side Shade Selection Guide offers four different stages of decalcification, or anterior stain. The colors underneath the stain are each different so as to contrast the internal vs. external colors and make them more obvious to the clinician and technician as they decide on the best possible match for the adjacent teeth.

Fig. 15: This image was adjusted with a gradient map filter as blue/yellow/blue in photo shop program for comparing patient texture with shade guide samples. The surface texture of a tooth has the same type of appearance as a fingerprint, with the direction of the surface texture determined by many things. Among them are brushing techniques and types of food a person may consume. This particular texture is best described as Horizontal Wave.

Fig. 16: Surface Texture, again clearly delineated through the computer graphics, is vertical in appearance, not straight but wavy with heavy areas of concentration in the pattern. Surface Texture can be as individual as the person to whose teeth it belongs.

Fig. 17: The texture of this patient's teeth is heavier in certain areas, creating an irregular lobe and a reflection. The horizontal lines are light in appearance, with the vertical lines being heavier. With the Chair Side Shade Selection Guide for comparison, the best description for this surface texture is Natural, TE-6.
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Fig. 18: The crowns created as samples of possible dehydration surface textures are above the pictures they became in the Chair Side Selection Guide: dull, rough and shiny being the possible three choices in this group.

Fig. 19: With six total surface texture possibilities, the three remaining are entitled Horizontal Wave, Vertical and Natural. Each crown was given a surface texture name and used in the Chair Side Shade Selection Guide as a communication tool for dentists.

Fig. 20: Through the study of maxillary natural, extracted teeth we can learn a lot about texture, shape, color variations and staining.

Fig. 21: Again, natural, extracted mandibular teeth provide a study tool for any technician who wishes to increase his knowledge about tooth morphology.

Fig. 22: Based on that research, as well as custom shading studies, the Chair Side Shade Selection Guide zirconia restorations were created and photographed for communication purposes.
Fig. 23: Research and development led to the improvement of dentin shade tabs compared to Vita in color selection. The materials differ in composition: porcelain vs. composite.

Fig. 24: In another experiment with color, sectioning of various shade tabs allows us to see thickness of enamel layering and apply multiple enamel modifier colors such as blue, white and pink to the original color. This changes the color of the shade tab from a single color to one of multiple dimensions.

Fig. 25: During the dehydration stage, vertical crack lines in the centrals become obvious but it is also important to note that the stump color is variable for this patient. Material selection must effectively cover the dark color.

Fig. 26: The finished restorations prove to be a successful color match and after prep color cover.

Fig. 27: Dehydration/hydration plays a role in the effective matching of the stump shade for central #8. The crown was eventually fabricated using GC Press Initial System.

Fig. 28: As a bisque bake, the crown was tried in the mouth and surface texture lines were drawn on by the technician after the dehydration effect, matching with the adjacent teeth.

Fig. 29: GC Initial IQ One Body Lustre Paste samples offer many possibilities to work with during the staining process.
With regard to enamel modification, the Chair Side Shade Selection Guide offers five anterior enamel colors from which to choose: Mamelon Clear, Incisal 1/3, Clear Incisal Enamel and White Clear as well as five posterior shades of blue from Light to Grey White. Enamel overlay will be applied in varying degrees of white, clear or translucent shades with categorical colors including grey, tan, blue, pink and clear, all in light, medium, or dark tones. Enamel overlay, the final step, will be applied to either the entire crown, the middle (body) area, or to the incisal edge of the tooth. However, regardless of how it is applied, it changes the color of the final restoration.

The cervical color translucency chroma application creates a natural appearance in the restoration, one that is not opacious and unnatural in appearance. Natural teeth do not have high chroma, but they do have mostly translucent chroma. This matching is a delicate matter. Enamel overlay with translucency and all the other possible combinations contribute to the basic differences we have been discussing.14, 15
Conclusion

Any dental technician, in order to be productive and time saving, has to have a strategy for custom shading. This means that his education regarding tooth morphology has to extend into understanding natural tooth color, shape and very detailed modifications. After he puts the puzzle together, the end results can be beautiful and the expertise of the technician is raised to a higher level. As the saying goes, “experience is the best teacher!” The more a technician studies natural teeth and takes the custom shade for patients, the more he learns about how to achieve the best results possible.

This leads to a clear understanding of the hydration/dehydration process. Technicians will not succeed with their custom shading procedures without it. There has to be a strategy in place ahead of time in order for the patient’s appointment to produce matching results. Which comes first, and which is last? When do we note the color of the adjacent teeth and when do we look for surface texture? What about mamelon, crack lines and translucency?\textsuperscript{16}

With good strategy and communication tools in place, we can offer the patients and clinicians a predictable and successful restoration. With everyone’s cooperation and a clear understanding of what’s involved in the color matching process, a technician’s work is sure to be exceptional and improve as time goes by.\textsuperscript{17}

Reference


About the author

Luke S. Kohng, CDT, is the owner of LSK121 Oral Prosthetics, a dental laboratory. He has published over 35 articles in major dental publications. He is the author of the recently published Anatomy from Nature, with 50 illustrated pages of full contour wax-ups, stone models and porcelain teeth, all re-created using natural teeth as a guide. His new Esthetic Guide Book features 31 patient cases from a single anterior tooth to a full mouth reconstruction. He invented the Chair Side Shade Selection Guide featuring over 150 zirconia fabricated restorations based on patient enamel and translucency research, with patent pending.