

How to Build a Great Partnership with the Technician: *Simplified and Effective Laboratory Communication*



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A dentist's clinical results are directly proportional to the communication skills we have with our laboratory. If the laboratory technician could be chairside and see exactly what we see, our restorations would improve. Dentistry is a visual science but often relies on inadequate words, feeble drawings, and poor photographs to communicate the many nuances of teeth texture, anatomy, and color that will be restored with non-natural materials.

If a picture speaks a thousand words, great photographs could fill a laboratory book. Precise visual communication with our laboratory can be the difference between a merely acceptable case and a great one. We can now take great photographs, put them on the computer, and send them to the laboratory before the anesthesia wears off; technology is much improved.

The ultimate in communication challenge is when matching a single

anterior tooth. Despite the skill of the dentist and technician, a relationship must be built on correct data gathering, its use, and refinement if expectations are not met (QA: belong to rest of sentence or separate?). It is frustrating to try in a restoration that is not up to expectations. Quality digital images may be the ultimate way to get what we want from the laboratory and to build that partnership needed to excel.

Why Digital?

Slide film (35 mm) with a quality camera is the standard in dental photography, but the hassles of developing, mounting, archiving, carousel loading, unloading, storage, and time to do each of these has made other options worth considering. For the last few years digital photography has advanced to resolve these issues and the quality has come near that of film. The slight difference in quality is easily made up for by ability to store, print, and manage the images.

Digital photography has become a great adjunct to modern dentistry. If we are not skewed by those selling goods from “experts” in a field a barely a decade old, we can have a system with great accuracy, versatility, and simplicity. After 10 years, thousands of wasted dollars, and several hard drives full of images, this non-expert has learned what specific things are needed for ultimate communication.

Equipment—Does Size Really Matter?

The value of the communication with the laboratory is directly proportional to the digital equipment used. When communicating with the laboratory, accuracy of the image is critical; it is all about exactness of the image captured. We must correctly reproduce tooth color, character, and surface texture and be able to get this to the laboratory without loss of detail.

The digital single-lens reflex (SLR) systems are clearly superior to their compact brethren. Their quality rivals 35-mm film and their versatility is unmatched by compact systems. Nikon D70 and D200 (Nikon, Inc), Fuji S2 and S3 Pro (Fujifilm), and

Canon 5D or 20D (Canon USA, Inc) are all capable cameras and with a compatible macro lens and flash system, we can have the ultimate in communication photography (Figure 1).

Point-and-shoot cameras are often purchased for their cost, small size, ease of use, and resolution values that are similar to more expensive cameras. This office has used several point-and-shoot models, Canon G5 (Canon USA, Inc), Olympus 5050 (Olympus), Fuji 602s (Fujifilm), that work well for face, smile, and full arch images but lack the versatility and precision of lens-changeable SLR cameras (Figure 2).

It is popular to send an over or under exposed quadrant image with a shade tab held at some obscure angle and expect the laboratory to match the detail of a tooth. This cannot be done consistently (**QA: Sentence does not belong here; out of place**).

The sensor is what replaces the film and is a critical part of the digital camera. Compact cameras usually have smaller, inferior sensors than their big brother SLR's. The sensor is made up of many light energy photon gathering points called pixels. More pixels are better if they repro-

duce color well, are arranged on the sensor correctly, and are of correct size themselves.

Certainly, how the image arrives at the sensor is also critical. A 100-mm or 105-mm macro lens allows the image to be enlarged in a distortion free way and worked on the camera for accurateness. Macro lenses give us the most versatility and are not limited by ability to capture minute tooth detail. Digital zoom by the camera or image software causes a loss in image quality and is a non-reliable source for the laboratory to work with.

Light control maybe the most important—and overlooked—aspect of all. Exposure is determined by how the camera and its flash are set. If an image is too light, the detail we need to mimic is not seen. If the light is not controlled correctly, we might as well just rely on the written laboratory order. For the most part, we want to control the light entering the camera by aperture settings, f-stop, and not by the metering system of the camera. The compact cameras can be equipped with light diffusers but still have the tendency to loose tooth detail needed for very detailed laboratory work as the flash is



Figure 1—Nikon D70 and Fuji S2 Pro with interchangeable Nikkor (**QA: not Nikon?**) and Sigma 105mm macro lenses and Nikon SB-29s Speedlights.



Figure 2—The Canon G5 and Olympus C-5050, have been used for face, smile, quadrant, or full arch images routinely but do not have the sensor and lens accuracy for capturing detailed nuances of the teeth.



Figure 3—Light diffusers are sold to make a more even flash lighting for close up photography with compact cameras.

bounced off a mirror and reflected through plastic (Figure 3).

Simplicity is the name of the game in a busy dental office. The “point-and-shoot” cameras are smaller, lighter, and easier at first glance, but an adjusted SLR camera is almost as easy to use when settings are memorized or written down. We use only a few small changes to achieve excellent images in almost every dental setting. Just turn the camera on, adjust the aperture (f-stop) by one little finger dial, and awesome images can be taken by any staff member.

Consistent Image Portfolio from the Dentist

Every dentist needs to decide on a series of images taken on every cosmetic patient that can be used for marketing, patient education, and liability. The images need to be consistent with camera setting, patient position, and image storage organization (Figure 4). These images must be sent to the laboratory so the technician has a feel for the soft tissue of the smile, teeth cant, alignment, protrusiveness, tip, and torque.

In addition to these images, others are taken to meet particular case

needs. For instance, porcelain veneer cases need to show tooth preparation shaded (QA: supposed to be shading?), bite registration alignment, and functional temporary images to help the laboratory construct the case (Figure 5). For individual tooth matching, other images will then be captured as described below.

Images should be stored on the computer in a folder with the patient name inside other folders describing the technique. All captured photographs are sent to the laboratory on a compact disk (CD) or other digital

medium along with a written laboratory prescription (QA: supposed to be description?). On the CD the office name, patient name, date, and procedure are written (Figure 6). Usually high quality image files are too large to be sent on the Internet and so the CD is sent with the laboratory case.

A histogram is basically a chart to show how the data is being collected by the sensor (Figure 7). If we assigned a level from left to right with 256 levels of “brightness” and counted the number of pixels recording that particular level of brightness,

we would make a graph. Zero “0” is black and white “255” with 254 levels of gray in between (QA: incomplete sentence?). Red, green and blue “RGB” levels are the total levels of brightness of all three colors.

Understanding the histogram may be the first key to great images. We are trying to have the data fill the entire histogram graph from right to left giving us a “full tonal range”. We would like to see the histogram data fill the chart so that accurate light is captured. Most SLR camera can be set so that a histogram can be seen at each image capture and f-

stops changed center the data in this chart (QA: Not sure what means?). This is a tremendous advantage in image quality for the SLR camera systems.

What is Expected from the Laboratory

It is all about communication. There is no need to waste time capturing precise color, tone, and value if the laboratory ignores the material or if it is used in an incorrect way. The less manipulation we have done with an accurate image, the better the laboratory can our needs (Table 1).



Figure 4—Consistent images for the office portfolio, practice promotion, and restorative evaluations should be taken by each office.



Figure 5—In addition to the office portfolio series, images are taken to aid the laboratory in restoration matching or, here, to show the preoperative tooth color.

Table 1—Expectations from the Laboratory

- Printed images used only as quick reference.
- Technician should have computer monitor at work station.
- Have monitors calibrated for accuracy.
- Digital images on a monitor used as reference with description or computer colorimeter for specific tooth character during fabrication process.
- Refer to images after restoration creation to verify accuracy of porcelain characterization.
- Call dentist if questions arise.

Every time the camera makes an adjustment, the editing software makes a change, or the printer spits out some ink, error may be introduced. Digital cropping and multiple editing steps on the computer increase time and are not necessary if the images are taken correctly with accurate detail.

The technician should have the ability to see a monitor while the restoration is being fabricated. There is a greater chance of accurate laboratory work if the images are viewed on a color corrected monitor (QA: Is this a type/brand of monitor?). Calibrating maximizes the settings for color, contrast, brightness, and

white balance. A colorimeter, like the ColorVision Spyder 2 (ColorVision), is inexpensive, simple to use, and can make a difference in image matching.

Any time images are printed on photograph paper from an ink jet printer the laboratory is only to use those as a quick reference and to introduce the case to the technicians. Each printer induces color error into the photograph because of printer settings, ink variances, paper, and other factors. It is dangerous to rely on these printings and even with printer color calibration; it is difficult to maintain correct color through the process.

Clinical Protocol for Single Tooth Matching

Retraction of soft tissues is critical to help control fluid and to keep

“Because we take the same few images over and over in dentistry, there are only a few f-stops to remember and, with practice, it becomes as easy as using a point-and-shoot camera.”



Figure 6—With each case is a written description, ink-jet printed images, and a CD of all images taken.

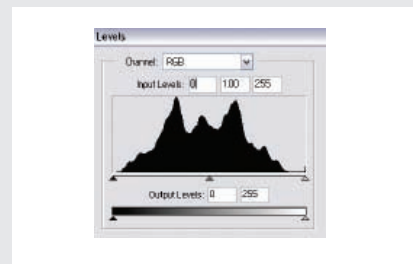


Figure 7—A histogram is a chart that shows the levels of “brightness” captured by the image.



Figure 8—A self-holding retraction system keeps teeth isolated and dry for photography and for restorative work.



Figure 9—When taking shades, the assistant holds the tabs at a plane even with the teeth to keep lighting consistent for accurate shade comparison.



Figure 10—The first image taken shows the shade numbers so there is no confusion about shade identification later.

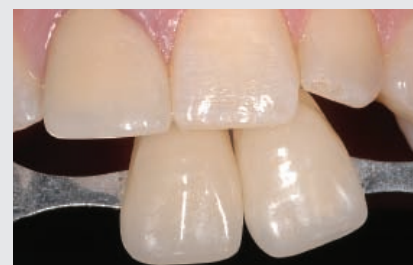


Figure 11—The tabs are slid closer together and captured at the incisal of the tooth being matched.

Table 2—Dentist Requirements for Single Tooth Laboratory Communication

- Retract soft tissues
- Dry tooth
- Focus as close as possible with a 100-mm to 105-mm macro lens
- Camera and patient very still during capture
- Use maximum f-stop to increase depth of field and to increase tooth detail that histogram allows
- Record in high-resolution RAW, TIFF or maximum JPEG
- Print and digitally copy images to send

tissues from showing shadows on the teeth (Table 2). Surface texture and true hues will not be seen if there is saliva, blood, bubbles, or debris on the surface; the teeth should be dry. Retractors that hold themselves, See More (Discus Dental), reduce the need for assistant or patient help, are

comfortable, and can be used during the operative procedure (Figure 8).

A black contrastor (Photomed) is used to decrease light reflection. This prevents obscuring of tooth detail in the image and potential overexposure from behind. When shade matching, the retractors are

placed, the patient holds the contrastor, the assistant holds the two closest in shade tabs near the tooth, and the dentist captures the image (Figure 9).

The shade tabs should be held on the same plane as the teeth being matched so they are the same distance from the camera sensor for consistent lighting. The first image is taken at a distance so that the shade tab numbers are clearly seen (Figure 10); this prevents mistaken shade tab identity. The tabs are then moved together without changing position and an image is captured showing the entire tooth and both shade tabs (Figure 11).

The necks are cut off the shade tabs or held behind the tooth because they are different in appearance than the middle of the tab. If the tab is behind the incisal of the

tooth, the translucencies of the incisal edge will be obscured. Therefore, a separate image must be taken without shade tabs that will highlight the character of this part of the tooth.

Because the preparation shade affects final porcelain color, the single closest shade tab to the prep color is chosen and held on the same plane as the tooth. The first image is taken to see the shade tab identity (Figure 12) and it is followed by a close-up showing the entire preparation and shade tab so the laboratory can figure this into restoration construction (Figure 13). Change camera angles slightly if glare covers a large portion of the image; this will give the laboratory enough data for a quality, not perfect (QA: needed?), match (Figure 14).

Camera Exposure mode and Image Formats

Some argument exists on which mode is best to shoot digital images in. Both “M” manual and “A” aperture modes allow light control by f-stop adjustment. The difference is that “M” allows shutter-speed, time aperture is opened, to be adjusted while in “A” it is automatic (QA: Sentence unclear?). So in “A” mode you select the size of the diaphragm the light goes through and in “M” mode both the amount of light and the time it goes to the sensor are controlled.

In dental reality, once a shutter-speed is selected it stays the same for all intraoral dental shots. If you check both modes, you will notice little difference in the tonal range as checked by a histogram on the cam-

era or editing software. SLR cameras as well as some compacts will allow you to see a histogram with every shot so that brightness accuracy is verified.

The format that the image is stored in is also important. “RAW” isn’t an abbreviation, it just means that the image is in an unmanipulated form. The image is unprocessed by the camera and contains the original information received through the lens and onto the sensor. Most new SLR cameras allow images to be captured in RAW and JPEG formats at the same time so that the quality is preserved in RAW and ease of use is accomplished by JPEG.

The JPEG images are smaller, easily managed, and do not require special software to manipulate. JPEG images are a “compressed



Figure 12—The preparation shade is taken in the same way.



Figure 13—Then the image is captured as close as possible showing the clean prepared tooth and all the shade tab minus the neck.



Figure 14—Even though not perfect, the resulting restoration matches in character, color, and texture to the adjacent tooth.



Figure 15—For restorations with incorrect shades, the restoration is placed in the mouth with a luting try-in paste that corresponds to the planned final luting cement.

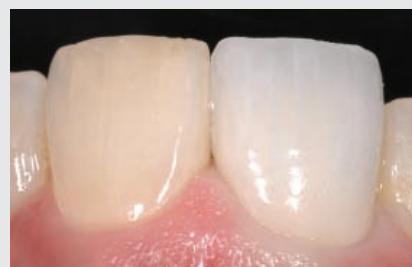


Figure 16—Incisal detail is captured for the laboratory with the 30° image.

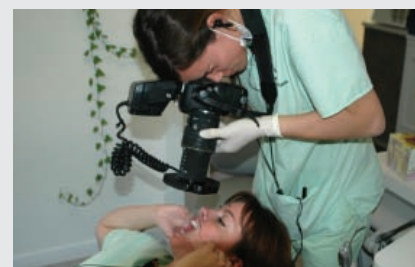


Figure 17—The image is captured at about 30° to the long axis of the tooth and is taken at maximum macro setting, 1:1, to highlight the incisal character.



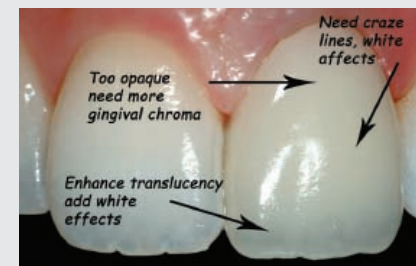
Figure 18—The resulting all-porcelain crown is a much better match and is clinically acceptable at the cementation appointment.



Figure 19—A full series of images was sent to a laboratory for an all-porcelain crown on tooth No. 9.



Figure 20—Failure of the laboratory restoration match can be seen for several reasons.



Figures 21—On a copy of the same photographs, arrows are drawn to point out desired changes.



Figure 22—Again, an incisal 30° image is always included so that the most difficult incisal area can be best copied.



Figure 23—The final restoration is much more acceptable and a remake would have been avoided had the laboratory consulted the original images sent with the case.

(QA: Is this what compressed means?)” format which means some data is manipulated and some data is thrown away. By using the highest quality of JPEG means less compression and less data loss. A key with JPEG images is that no image manipulation of the photograph is done because with each change in the editing software, there is unrecoverable data loss.

Restoration Surprises

Occasionally an anterior crown comes back with a bad match. Even if the laboratory is blamed to save face in front of the patient, the error often lies in the communication from the dental team. Place retractors, insert contrastor, hold the desired shade next to the tooth, and try the crown in with try in paste that mimics the final luting cement (QA: Is this a solution to the communication problem? You say what could happen then launch into a technique description?) (Figure 15).

Then (QA: Is this a step from the above process? Start with ‘Then?’) to highlight the incisal nuances take an image at 30° down the long axis of the tooth (Figure 16). This view is excellent for pointing out incisal

character missed from other views and is taken from an angle behind the patient (Figure 17). The laboratory had a much better idea of what to match with this information and it is clear that the technician used the images provided this time (QA: Use of first person; hadn’t used at all till this point?) (Figure 18).

Matching a single tooth with high degrees of translucency and character can be difficult (Figure 19). Despite quality images, detailed color mapping, and use of a quality laboratory, the results were off a considerable amount (Figure 20). The laboratory failed to consider the images sent and failed to give time to detail. Multiple errors in the restoration make communication even more critical. Images are captured as before in a macro setting with maximum f-stop to allow full tonal range (QA: Sentence seems out of context?).

Images are retaken with shade tabs as before and a duplicate copy is made so that specific problem areas are point (QA: Are point?). Texture, areas of incorrect color, bulkiness, and characterization flaws can be pointed out clearly (Figure 21). Another view from the incisal is sent

to show traits missed in incisal edge formation when compared to the adjacent teeth (Figure 22). By using the images sent with deficiencies noted, the result was much more natural (Figure 23).

Because most anterior restorations today are metal free, there is potential for the prepared tooth to show through and influence the final restoration color. It is very important to communicate to the laboratory all details of preparation color, intended cement, and opacity of porcelain desired. For very dark teeth all factors must be considered (Figure 24). The laboratory knows and is familiar with the luting agent and builds in enough die spacer to cover the color with that cement (Figure 25). This can result in a more natural porcelain result that hides color and has vitality (Figure 26).

Summary

Precise digital images can be a tremendous asset for most dental offices. Communication with accurate images can help in case fabrication, precision tooth matching, and correction of failures. Now if we only had a digital dentist so we could stay home and email our hands to

the office. ©

Disclosure

The author has no financial interest in any way with the products, materials, or suppliers used in this article.



Figure 24—Medication stained teeth often appear darker after preparation and to avoid show through or restorations that are too opaque, the preparation shades must be accurately shown.



Figure 25—A thorough laboratory can take the information given and use techniques to mask color skillfully.

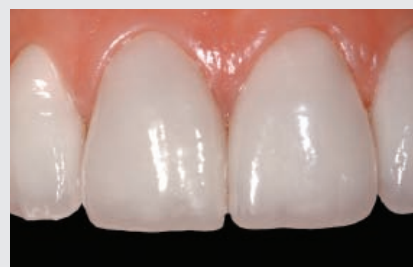


Figure 26—With this information, the laboratory can construct thin veneers that both mask color and maintain vitality.