



# Photography in Dentistry

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## A B S T R A C T

*The use of photography is becoming a standard for today's modern dental practice. Dental imaging is critical for the sharing of visual information among the patient, dentist, and ceramist. This article covers the basics of camera, lens, and flash selection, and the use of camera flash systems. It will also provide guidelines for obtaining a good dental image.*

**T**he use of photography, whether film-based or digital, is becoming a standard for today's modern dental practice. Dental imaging is critical for the sharing of visual information among the patient, dentist, and ceramist. Most people are visually oriented ("a picture is worth a thousand words"), which makes it significantly easier to use visual documentation to demonstrate problems and thus motivate patients to accept needed treatment. The ceramist who fabricates the porcelain restoration needs as much shade data as possible to be able to duplicate the shade of the adjacent natural teeth; photography is best-suited for providing this information. A dentist should also provide the ceramist with images of the finished work after cementation to give feedback,

which allows the ceramist to learn and improve his or her techniques. Film-based and digital photography can be used to develop a smile portfolio of before-and-after cases that are useful in demonstrating to a patient what is possible. More importantly, the patient will get a sense of how good an esthetic dentist the practitioner is by viewing actual finished cases.

The process of choosing a camera and flash system can be confusing. Many different systems are available. Is a film-based or digital system more appropriate? This is a fundamental question frequently being asked today. The main advantage of digital photography is that the image can be viewed immediately. If the photographic variables were incorrect, the dentist would know it instantly and could correct them and retake the photo. It is important to understand that the basics of using a camera are the same for digital and film-based photography. The operator has to understand metering options, f-stop (aperture) settings, flash options and positioning, lens and magnification ratios, exposure bracketing, film selection, and composition. This might all seem very confusing and like a lot of work, but the basics of taking a good



photograph are really quite simple. This article covers the basics of camera, lens, and flash selection, and the use of camera and flash systems. It will also give guidelines for obtaining a good dental image.

### **Camera Body Selection and Camera Settings**

The selection of a camera body is really the least critical of all the elements of obtaining a good image. The standard for dental imaging has been the 35 mm format; many different manufacturers make cameras for this format. Depending on the features desired, a camera could cost as little as \$200 or up to \$7,500 for a high-end digital model (Figures 1 and 2). Durability, elaborate matrix-metering systems, extremely rapid auto-focusing systems, and fast multiple exposure options drive up the cost of a camera. Very few of these options are necessary for the type of imaging performed in dentistry. A high-end camera is appropriate for people planning to do action photography or imaging in variable lighting conditions. For dental imaging, all the features necessary for an excellent photograph can be obtained in camera bodies costing from \$500 to \$900.

The critical features a camera should have for dental imaging are through-the-lens (TTL) focusing, an exposure and flash-metering system, matrix metering, spot metering, exposure compensation that allows plus or minus three stops exposure value (EV) changes in 1/2-stop increments, aperture priority exposure settings, and manual exposure settings.

### *TTL vs. Manual Flash Exposure*

Many high-end photographers use all manual exposure and flash settings to create exactly the effects they want, and the dental photographer may choose to do this. This may require a significant time commitment and trial- and-error experimentation to find the correct settings for each scene. Cameras and flashes with TTL features allow the user to shorten the learning curve and minimize the guesswork on the exposure settings. The camera flash (Figure 3) is set in the TTL mode; and when the exposure is made, the camera meters the scene and fires the electronic flash. The camera automatically adjusts the light output to expose the scene based on the exposure (aperture and shutter speed) and metering settings of the camera. For most dental photography, the camera should have TTL features and the flash set in a TTL exposure mode. Rule No. 1: Choose a camera that has TTL metering and manual exposure settings.

### *Spot and Matrix Metering*

The camera should have both matrix- and spot-metering capabilities. Surprisingly, many cameras do not offer spot-metering options (sometimes center-weighted metering is said to be comparable, but it can give a significantly different exposure). Most dental images should be spot metered due to the high contrast nature of the area to be imaged (Figure 4). Essentially, in spot metering the camera is only metering the area within the small spot seen in the viewfinder; the exposure is based on this reading only. Dental im-

ages are generally of high-contrast scenes, that is, there are bright and dark areas. If the camera is set in matrix or center-weighted metering, a significantly larger area of the scene is metered. Matrix metering meters the whole scene as seen in the viewfinder, but it applies more weight to the center areas of the scene. If the scene has a lot of contrast, as do dental scenes, then the camera tries to balance out the exposure of the light and dark areas of the scene. Because the camera is trying to bring up the exposure of the dark areas, this almost always results in overexposure of the lighter areas of the scene, i.e., the teeth (Figure 5). Rule No. 2: For most dental scenes, the photographer should spot meter the part of the scene he or she wants correctly exposed.

For facial photography, matrix metering is OK as long as there is no significant contrast in the scene, such as a black background. If there is a background with a lot of contrast, an area of the face should be spot metered (Figure 6). Rule No. 3: Choose a camera that has spot- and matrix-metering capabilities.

### *Aperture Priority*

Most dental images should be taken with the camera set to the aperture priority exposure setting (Figure 7). When the camera is set to aperture priority, the user selects the lens aperture (e.g., f-22) that will allow the proper amount of light through the lens for the correct exposure. The camera then adjusts the time of exposure to correctly expose a scene. When the camera flash is set to TTL, the



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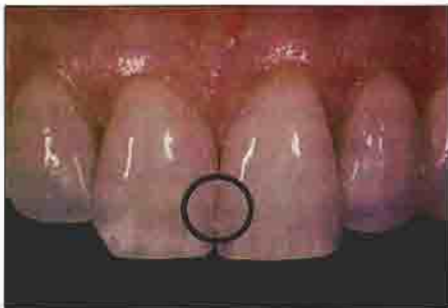
**Figure 1.** Film-based camera body (Nikon N90S) with all the features necessary for dental photography, priced less than \$600.



**Figure 2.** Digital camera body (Fuji FinePix S1 Pro), price approximately \$3,000.



**Figure 3.** Electronic flash with manual and TTL settings. The flash is set in the TTL mode.



**Figure 4.** Image of natural teeth properly exposed looking through the viewfinder of the camera. The small round circle (spot) should be placed entirely over a tooth and the camera set in spot meter mode.



**Figure 5.** Image of natural teeth that are overexposed in the slide. This was due to the camera being set in the matrix-metering mode, which metered the whiter teeth and the darker background. The camera tried to bring up the exposure of the darker areas, thus overexposing the teeth.



**Figure 6.** Full-face image properly exposed. Due to the high contrast in the scene, spot metering should be done on an area of the face. The figure illustrates where the spot in the viewfinder should be positioned on the face.



**Figures 7a, b, and c.** The aperture setting on some cameras will be a simple dial set to A or Ap as in (a); or, in more-sophisticated cameras, an exposure "mode" button (b) is pushed and the dial is adjusted until the LCD screen reads A or Ap (c).



shutter speed is set to sync with the flash; and the flash output then changes to correctly expose the scene based on the aperture setting, or f-stop setting, on the lens. The film speed will also affect the flash output and shutter speed and will be discussed later, along with lens and f-stop settings. Rule No. 4: Choose a camera that has an aperture priority setting because most dental images are taken with the camera set in this mode.

#### *Exposure Compensation*

It is critical that a camera be selected that allows for exposure compensation. This is accomplished by changing the EV (exposure value) setting on the camera to either a plus or minus value (Figure 8). This allows for a photographic technique termed bracketing. By changing the EV to a positive or negative number, the camera will either overexpose or underexpose the scene by the amount of the setting. As an example, by changing the settings to EV + 1, the camera overexposes the scene by one f-stop over no exposure compensation. For each full EV setting, there is either a doubling of the amount of light hitting the film plane, or a halving of the amount of light hitting the film plane, depending on whether the setting is plus or minus one. The term bracketing means to take an exposure slightly over- or underexposed relative to the main exposure (thus a minimum of three exposures are taken). This allows for errors in metering in the hopes that one of the photographs comes out correctly exposed. A camera that allows for EV

adjustments in 1/3 or 1/5 f-stop increments is best. Rule No. 5: Make sure the camera allows for exposure compensation of up to plus and minus three stops.

Even with the camera set to TTL, spot metering and aperture priority, it is still important to bracket the exposures of each scene one stop over- and one stop under-exposed from the camera's metered settings. The camera should spot meter off the teeth, which is the area that should be correctly exposed. In situations where the teeth are darker than normal, the camera may try to lighten the scene more than is necessary, resulting in a slightly overexposed image. Conversely, extremely light teeth might be slightly underexposed. Bracketing will minimize this problem. For true aficionados, trial and error with manual settings will be the way to go. Rule No. 6: Bracket important images.

#### **Lens Selection and F-Stop Settings**

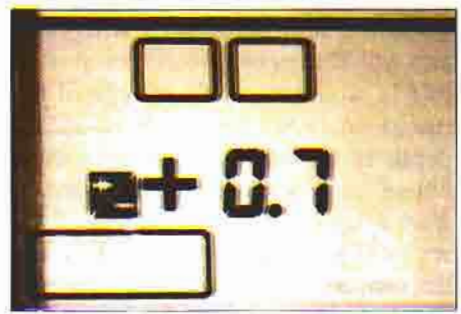
For dental imaging, a macro lens of fixed focal length of 100 to 105 mm is ideal (Figure 9). The term macro means close-up, and lenses designated macro (Nikon uses the term "micro") have special optics that allow the focusing necessary for close-up imaging. The lens must have 1:1 to 1:10 magnification settings. At the 1:1 magnification setting, an object measuring 10 mm, such as a tooth, will measure 10 mm on a 35 mm slide. Conversely, at a 1:10 setting, the same 10 mm tooth would measure 1 mm on the 35 mm slide. The 1:1 setting is ideal for close-up imaging of teeth and will generally include the four maxillary incisors on

the film plane. The 1:10 setting is used for full-face shots. Lenses in the 90 to 105 mm range are known as portrait lenses because they provide distortion-free images at the working distance of portraiture photography. Other lenses, e.g., 60 mm macro, can also have a 1:1 magnification setting but are not ideal for most dental imaging. Because of the wider angle of view, areas that are closer to the camera are distorted and appear unnaturally large. This is very uncomplimentary in portraiture photography since it makes noses appear larger than normal. At 1:1 settings, 60 mm lenses focus too close to the subject and thus cannot be used for intra-oral mirror images. Rule No. 7: Choose a macro lens with a 90 to 105 mm focal length that allows 1:1 magnification settings. The macro lens should also allow for f-stop settings of minimum aperture (f-32).

Changing the f-stop settings on the lens changes the lens aperture (Figure 10). Opening or closing the aperture allows more or less light to reach the film plane. The f-stop number is a ratio of the focal length divided by the lens aperture diameter. Thus, when the lens is focused at 100 mm from the film plane and set at f-22, the aperture will be 4.5 mm. A larger f-stop setting results in a smaller aperture opening. Smaller apertures will give greater depth of field. Depth of field is the amount of the scene in front of and behind the focal plane that will be in focus in the image. For each change in f-stop, there is a doubling or halving the amount of light that reaches the film plane. For most close-up dental images, an f-stop setting of 22 is best.



**RULE NO. 5: MAKE SURE THE CAMERA ALLOWS FOR EXPOSURE COMPENSATION OF UP TO PLUS AND MINUS THREE STOPS.**



**Figures 8a, b, and c.** Exposure compensation (EV) controls on a camera are generally labeled "+/-," either on a simple dial (a) or on a button (b). The dial is adjusted to + or - values to bracket the exposure. Cameras with LCD screens will display the numerical value of the desired exposure compensation in + or - values (c).



**Figures 9a and b.** The 105 mm Micro-Nikkor lens from Nikon (a) and the 105mm Macro lens from Sigma (b). After-market lenses by Sigma and Tamron yield dental images that are undetectable from either Nikon or Canon lenses, and they are half the cost.

**Figure 10.** Aperture adjustment setting on the barrel of the lens. Changing the setting (f-stop) opens and closes the internal diaphragm of the lens, allowing in more or less light.



**Figure 11.** Extension tube and teleconverter for increased magnification. The extension tube is a hollow tube, while the teleconverter is a magnifying lens.



**Figure 12.** Single-point source electronic flash.



**Figure 13.** Typical ring light electronic flash.



F-32 may not allow enough light to reach the film plane even with flash and would thus be underexposed. F-16 or f-11 would not have enough of the image in focus due to the smaller depth of field. For some mirror shots where no ambient light is present, it may be necessary to expose at f-16, which would allow more light in and thus ensure a proper exposure. For portrait photography, f-5.6 or f-8 is best because the depth of field is adequate; and these f-stops allow enough light to reach the film plane for proper exposure. For images of greater than 1:1 magnification, extension tubes (Figure 11) — which are essentially hollow tubes — are added to the lens to increase its focal length. These are better than teleconverters, which are essentially magnification lenses. Lens elements decrease the amount of light hitting the film plane and create problems with exposure. Rule No. 8: Most dental photography is done at f-22, and facial images at f-8.

### Flash/Lighting Systems

The proper illumination of a scene is one of the most critical aspects of imaging. Natural or studio lighting provides inadequate light for dental photographic situations, due to the small lens apertures and slower (less light-sensitive) film used. Thus, the only practical source of illumination is one of several types of electronic flashes. Electronic flashes for dental photography should have a color temperature of 5500K; most are manufactured with this color temperature, but one should ask to be sure. Color temperature of 5500K is said to be daylight-balanced, and flash-

es of this color temperature are to be used with film designated as daylight-balanced. The other main type of film is called tungsten-balanced, which is color-balanced for tungsten lighting. It has a color temperature of about 3200K. There are three basic types of flash systems for dental photography. The single-point light source; the dual-point light source, of which there are two kinds; and the ring light.

The single-point light source (Figure 12) is generally a small flash mounted on the side of the lens. This type of flash is good to show surface detail and contour. If this flash is used, it is best to take several images with different flash positions to give a complete picture of the contour and surface detail. Due to the fact that one light source is coming in at an angle, this type of illumination does not give an adequate representation of translucency or depth. To obtain photographic information about translucency and to minimize shadowing, a dual-point or ring flash is better.

The favored light source among dental photographers has been the ring light (Figure 13). This is the best light source for mirror exposures in the back of the mouth, due to the even illumination provided by the ring light. For anterior shots, it produces even and consistent (but not ideal) results. Because the light surrounds and is generally slightly in front of the lens, it eliminates all shadows. The specular or mirror-type reflection created by this type of flash tends to flatten out the image, giving a less-than-lifelike result. The results are acceptable, however; and this sys-

tem is easiest to master and to train a dental auxiliary to use. A system already put together specifically for dentistry that is easy to use and gives consistently acceptable results is the Yashica Dental Eye III (Figure 14).

The ideal flash for anterior photography is the dual-point source flash, of which there are two kinds. Lens-mounted dual-point sources look similar to a ring flash (Figure 15), but due to the fact there are only two flashes (which are vertically aligned bars) on either side of the lens, there is no light coming from the top or bottom of the lens. This positioning allows for some subtle shadowing, which creates an image with more depth and lifelike effects.

The other type of dual-point source flash uses a special bracket that attaches to the camera body, which allows custom positioning of the flashes (Figure 16). Mastering the use of this type of flash system will yield professional photographic results (Figure 17). Generally the flashes are set away from the lens about 3 inches and slightly behind the lens, which gives the best images. With the light coming in at a slight angle, there is less specular reflection and some slight shadowing is created; this gives the greatest depth to the image. All of the color effects and crack lines can be seen from these images. Subtle color gradations and translucency levels are displayed best using this type of flash system. Camera manufacturers don't make this type of flash system; the dental photographer would have to purchase after-market brackets and put together a custom flash system to ac-



THE PROPER ILLUMINATION OF A SCENE IS ONE OF THE MOST CRITICAL ASPECTS OF IMAGING.



**Figure 14.** The Yashica Dental Eye III.



**Figure 15.** Dual-point light source with the light sources mounted at the front of the lens (Nikon SB 29).



**Figure 16.** Custom dual-point light source system that allows individual positioning of the flashes. The best images are obtained with this system.



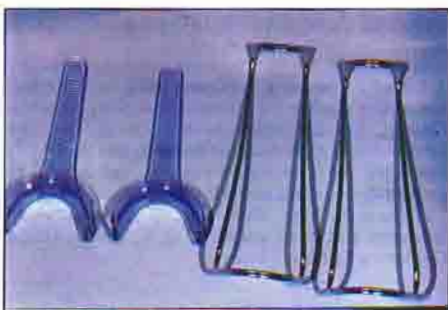
**Figure 17.** Image of all-ceramic crowns on the maxillary anterior teeth done with the dual-point flash system.



**Figure 18.** Professional Kodak Ektachrome EPN 100 film.



**Figure 19.** Image that was exposed properly but underdeveloped. When this happens, the slide will appear darker and slightly bluer than ideal. It is important to note that underexposing the image will create the same effect.



**Figure 20.** Plastic and metal cheek retractors. Either type is acceptable.



**Figure 21.** This image demonstrates the correct use of retractors, which pull and separate the cheeks away from the teeth and gingiva.



compish this type of photography. Rule No. 9: Dual-point light sources give the best image.

### Film Selection

For dental imaging purposes, transparency (slide) film is best. Slide film generally tends to be more color-accurate than print film, and if prints are necessary it is easy to make them from slides. Slide film ends in the designation "chrome," e.g., Ektachrome or Kodachrome (Figure 18). Print film ends with the designation "color" (e.g., Kodacolor). Film is sometimes called slow or fast film, which is an indication how light-sensitive it is. Slower film needs more light for proper exposure, and one way to get more light on the film plane is for a longer or slower shutter speed, thus the designation slower film. Faster films require less light and thus use faster shutter speeds. The speed of the film is related to the number of light-sensitive silver halide grains in the film. The more grains, the faster the film and the less light that is necessary for proper exposure. The problem is the higher number of grains, the grainier the image becomes (i.e., detail is lost). For dental applications, a film with an ISO rating of 100 is ideal; It is fast enough to allow correct exposure with the equipment and camera settings previously discussed.

Professional film is best because the color accuracy of the film is better than that of consumer film. Color-neutral and low-contrast film is best-suited for accurate color reproduction in dentistry. Kodak EPN 100 (Figure 18) or EPP 100 produce the most color-accurate images with the correct contrast. Contrast is a

measure of the differences of the light and dark areas of a scene. A normal-contrast film would image the contrast of a scene as it is, a high-contrast film would add contrast (i.e., make the lighter area of a scene whiter and the darker areas of a scene blacker). Kodak has recently started selling a film called Dental Photographic film, which is EPN repackaged. Twelve exposure rolls of the dental film cost the same as a 36-exposure roll of EPN, thus if one is taking several images, EPN is a better value. It is also extremely important that the film be processed at a high-quality professional processor. Even with all the correct camera parameters and correct film, if it is processed incorrectly, the final result will be poor (Figure 19). Rule No. 10: Choose a professional film of neutral color balance and normal contrast.

### Mirrors and Retractors

Mirrors are required for occlusal and buccal views in the posterior region. Front-surface-reflection mirrors are best for dental images because they don't create a dual image, which a rear-surface-reflection mirror can give. Glass mirrors generally give a better image than polished metal mirrors. The polished metal reflects less light than the glass mirror does and seems to slightly distort the image. Retractors come in two varieties, either metal or plastic (Figure 20). The larger plastic retractors give slightly better retraction than the metal ones, but the metal retractors will last significantly longer because the plastic ones become brittle and fracture after repeated sterilization. Retractor choice is a personal preference because there is no clear advantage for either

one in terms of cheek retraction. The important point for dental photography is to retract the cheeks away from the teeth and photograph the teeth with no cheeks, lips, or retractors showing in the photograph (Figure 21).

### Discussion and Summary

Dental imaging is critical to the success of a modern dental practice. The basics of using a camera for dental imaging are the same for film-based and digital formats. Neither system compensates for errors in exposure; the main advantage of a digital camera is that the image can be viewed immediately so exposure adjustments can be made. Although it is possible to import both film-based and digital images into a computer and digitally manipulate them to correct exposure problems, it is significantly easier to learn the use of the camera and obtain the correct exposure initially.

The camera body is the least critical element in obtaining a good dental image. Very expensive cameras and lenses are not necessary to obtain a good image. The flash system, lenses, film, exposure, and proper processing are critically to making the most of dental photography. **CDA**

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