Clinical digital dental photography

Author_ Dr Amit Patel, UK

Over the past decade, the availability of digital photography, digital imaging systems and digital presentation software programs has revolutionised teaching and lecturing.

Before the advent of digital photography, it was expensive to purchase dedicated 35 mm dental photographic equipment and accessories, and it was more likely to be dentists who were also amateur photographers who bought such equipment. Since the development of digital cameras, the costs have been brought down quite considerably. This has made it more accessible for most dentists in their everyday practice. The main advantages of digital versus film photography are instant image acquisition, reduced costs of film processing and a relatively easy learning curve.

It is very difficult to outrace technology, as it is evolving daily at a rapid rate and one will always be behind. So don’t plan on using your current digital equipment for the rest of your life; it is always outdated within a couple of years. Over time as our own skills and knowledge improve with digital pho-
Digital photography, we will want to improve on our old images; therefore, reinvesting in technology is part of the challenge in the pursuit of excellence.

One of the biggest advantages of digital photography is that the images can be viewed instantly and can be edited in many ways, such as improving brightness and contrast, cropping, changing hue and saturation, adding text and symbols, using software.

_Types of cameras_

Digital SLR (single-lens reflex) cameras are high-end cameras designed for semi-professionals to professionals (Figs. 1a & b). Recently, most of the major camera brands have developed a range of affordable DSLRs, allowing us to develop our clinical photography skills over time to achieve higher standards in our practice.

DSLR cameras have the advantages of interchangeable lenses, including macro and telephoto, metered lenses, and ports for accessory flashes, such as a ring flash or a dual flash system. One can also choose between manual focus and autofocus cameras. Although the modern camera can control a number of key settings relating to the exposure and flash levels, these can normally be set manually.

These types of cameras can be expensive and bulky to use for clinical photography. A good number of the point-and-shoot style of digital cameras are available at reasonable prices and take excellent clinical photographs even at a macro level. I have been using a Nikon Coolpix 4500 (Figs. 2 & 3) since 2003, which allows macro images up to 2 cm from the object and with which I have obtained good results (Figs. 6–14).

The advantages of the smaller point-and-shoot style cameras over DSLRs is that they are less bulky, lightweight and compact, and work well for most clinical cases. There is also no need for multiple lens changes.

_Digital camera jargon_

Digital cameras capture images as elements, known as pixels. A megapixel is equal to one million pixels. The more pixels contained in an image, the higher the image resolution. Resolution relates primarily to print size and the amount of detail in an image when viewed on a computer monitor at 100 per cent magnification.

Images with more megapixels yield better print images. Many amateur and professional digital photographers crop their photographs, sometimes reducing them dramatically in size, to focus on the key element of the image. Obviously, the more pixels in an image, the more can be cropped while retaining a useful image.

I consider that six megapixels is sufficient for use in clinical digital photography. It gives one the...
Special digital photography

ability to use the images for presentation to patients and for lectures using software such as Microsoft PowerPoint (www.microsoft.com) or open-source software that can be obtained from the Internet, such as OpenOffice (www.openoffice.org), and to print reasonable size images (300 x 450 mm) for poster presentations.

The images are stored on a CompactFlash card (CF card) or Secure Digital card (SD card), for example. There are many file types (RAW, JPEG and TIFF) that all serve different purposes. A RAW file is comparable to the latent image contained in an exposed but undeveloped piece of film. This means that the photographer is able to extract the maximum image quality possible, whether now or in the future. This format is mostly used in professional photography. A JPEG file is a file that is compressed and when saved loses its quality. This results in a lower quality and smaller image file. For many applications, the image quality is more than sufficient. The smaller files also make it easier to transmit electronically. A TIFF file is also compressed but the file does not lose quality upon being saved; therefore, TIFF files are larger than JPEG files. TIFF format images can be utilised in presentation software, the only drawback being that the software may run more slowly owing to a larger file format. I am inclined to use the JPEG Fine format to save the images, as they are easily transferred to the computer and can be used for presentation purposes.

Standardising images

It has never been easier to take standardised photographs and use high-quality controlled clinical images. Focal distance can be standardised by securing a piece of dental floss or chain to the bottom of the camera and holding it near an appropriate area (chin) of your patient. This ensures that you will be at the same distance from the patient for all views.

For macro photography, a macro lens and ring flash for a DSLR can be used for capturing close-up images of the subject. Ring lights (usually a ring of LEDs fixed to the lens) can also be obtained for most point-and-shoot cameras (Fig. 3). It is not always essential to have all these accessories, as you do not need to get close to the subject. These cameras automatically compensate for various lighting conditions and some can compensate for macro distances.

Getting too close will overexpose some areas and block the flash in other areas, causing shadows. The best technique is to keep away from the subject and use the optical zoom to get close to the area. By doing this, you are far away enough for the flash to disperse over a larger area. With digital editing, you can crop any extraneous anatomy. If the image is taken at a high resolution, your image will be of sufficient magnification after cropping the unwanted structures (macro-like).

Basic functions

There are four exposure settings (modes) in the majority of DSLR cameras and all employ a through-the-lens metering system:

Aperture priority

The aperture is the lens opening. So the aperture control allows the photographer to
control how far the lens is opened when a picture is taken. The farther the lens is opened, the greater the amount of light that is allowed into the camera and the lighter the exposure. Once the aperture value has been selected, the camera automatically selects the correct shutter speed to produce an acceptable exposure. By setting the aperture value, the photographer decides on the depth of field (the plane of sharp focus) in the image. One can select a small aperture value (a high f-number) for a larger plane of sharp focus (Fig. 4) and a large aperture value (a small f-number) for a narrow plane (Fig. 5).

A depth of field problem is that the entire dentition can only be photographed completely in sharp focus if the focal plane is positioned carefully. Therefore, do not focus on the anterior teeth (yellow circles on Fig. 4). For a frontal view, the point of focus should be around the canines (yellow circle on Fig. 5).

**Shutter priority**

The shutter speed controls the amount of light that enters the lens when the picture is taken. The more light desired, the slower the photographer should set the shutter speed. Once the shutter speed has been selected, the camera automatically selects the correct aperture value to produce an acceptable exposure. This mode is not used for the purpose of intra-oral photography.

**Program**

The camera automatically selects both the aperture and shutter speed based on a built-in program.

**Manual**

The photographer selects both the aperture and shutter speed, but the camera’s built-in meter can still be used to calculate the correct exposure.

For dental photography, it is important to be in control of the exposure features. Therefore, either the aperture priority or manual exposure settings are preferable.

**Accessories for intra-oral photography**

Cheek retractors and intra-oral photography mirrors are essential tools for dental photography (Table I). Using these tools allows us as clinicians to teach and improve team involvement of all the staff. I feel that it is important to delegate the process of intra-oral photography to other members of staff; therefore, it is essential to teach and emphasise the standardisation of all the images taken so that any member of staff trained will achieve the high standards required.

Orientation of the image is important. The occlusal plane should run parallel to horizontal frame of the photograph through the view-finder, as a photograph taken from below will distort and alter the perspective of the teeth. Lateral photographs should be taken perpendicular to the teeth using a mirror (Figs. 7, 8 & 11a). Lateral photographs without mirrors will only show a few teeth, as the metered focus will be on the canines and first premolars (Fig. 11b). For occlusal views, the camera should be as near as perpendicular to the occlusal mirror (Figs. 9 & 10).

**Tips for dental photography**

- Use cheek retractors;
- Use dental photography mirrors (warm using the three-in-one to remove fogging and saliva bubbles);
- If the image is too bright, increase the f-number (reduce aperture size);
- If the image is too dark, decrease the f-number (increase aperture size);
- Take as many photographs as you like, as you can delete them later.

**Tips for dental presentations**

- Use the crop tool to remove cheek retractors;
- When using presentation software, use a black or white background for your images;
- Don’t use too many transitions, as this can be distracting to the audience;
- Definitely don’t use any sound effects.

**Recommended digital SLR cameras and their settings for intra-oral photography**

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<th>Camera</th>
<th>Nikon DSLR</th>
<th>Canon DSLR</th>
<th>Nikon DSLR</th>
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<tr>
<td>Flash</td>
<td>Nikon R1C1 flash</td>
<td>Sigma ring flash or Canon ring flash</td>
<td>Sigma ring flash</td>
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<tr>
<td>Power setting</td>
<td>TTL</td>
<td>eTTL</td>
<td>1/4</td>
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<tr>
<td>Aperture value</td>
<td>F22</td>
<td>F25</td>
<td>F25</td>
</tr>
<tr>
<td>Shutter speed</td>
<td>1/160</td>
<td>1/125</td>
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When taking images of isolated teeth, one way of improving the image is by using a black background (contraster). The black background improves the image quality and highlights the translucent regions of the teeth (Figs. 12 & 13).

**Radiographs**

Taking images of plain film radiographs can be difficult. The film is placed on an X-ray viewer box and the image is then taken. In most cases, there will be a greyish green cast to the image. This is due to the fluorescent light in the X-ray viewer that produces flicker at the mains frequency. Essentially, when the image is taken, the fluorescent light may be flickering on or off, thereby affecting the colour of the image (Fig. 14a).

There are many complicated ways of overcoming the colour cast, but we have found two methods that appear to achieve the desired results more easily. The image can be manipulated to produce a black and white image (Fig. 14b) using bought software such as Adobe Photoshop (www.adobe.com) or using open-source software such as GIMP (www.gimp.org). The second technique—and the easiest—is to set the digital camera to capture images in black and white (Fig. 15).

**Presentation software**

For presentations, I use OpenOffice. It is virtually the same as Microsoft Office; the only difference is that you can save the documents in any format available, such as those used by Microsoft Word and Google Docs. OpenOffice offers a program called Impress that is equivalent to PowerPoint. I like to use a black or a white background for my slides, as this makes the images more prominent on the slides (Fig. 16; Table II).

These presentations are used both for patients as an education tool and for lecturing purposes. I also find it useful to take a photograph of the nearest shade tabs to the adjacent tooth so that all information available can be sent to the laboratory technician (Fig. 17). The image is sent as either a JPEG or an OpenOffice Impress file to the laboratory. The technician will be able to use the image to create a restoration with the correct shade and characterisation. I also use the images taken pre- and post-operatively of any restorative and implant work and supply the images to the dental technician, as rarely do technicians see their own handy work in situ.

I also use another open-source program (GIMP) to manipulate the images, that is to crop out any unwanted distractions, such as the retractors (Figs. 18 & 19; Table III). Using this software, it is possible to reorientate the image if not level with the horizontal plane using the rotation tool. The image is simply saved and imported into the presentation program.

**Conclusion**

According to Moore’s law, the number of transistors in integrated circuits has doubled every year since the invention of the integrated circuit. Moore predicted that this trend would continue. It is thus evident that by the time this article goes to print, camera technology will have made further advancements, but the principles of capturing an image will remain the same. Observing the simple rules to ensure standardised images will allow all members of the dental team to obtain good quality images. An important consequence of digital dental photography is the ability to check and improve the images.

Interestingly, whilst writing this article, the World Mobile Congress was held in Barcelona in February 2011. Many tablet computers were showcased at this event (Fig. 20a–c). The use of these newer tablets in everyday practice is an important patient education tool. One’s images can be archived on the tablet and imported into presentation software, making it more patient friendly. The tablet can then be used by the dental team to educate patients. It is important to be aware that dental photography is an essential part of dentistry used not only to document, but also to illustrate and educate.

*Editorial note: A complete list of references is available from the publisher.*

**about the author**

Dr Amit Patel  
Specialist in Periodontics & Implant Dentist, Associate Specialist Birmingham Dental Hospital, Honorary Clinical Lecturer University of Birmingham School of Dentistry