Digital Imaging for the General Dental Practitioner: 2. Intra-Oral Imaging

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Abstract: Digital imaging is ideal for producing images in General Dental Practice. Many of the techniques used with conventional 35 mm equipment are still good practice, though there are many additional functions available with digital cameras, and many other tools available on the computer. Making best use of the functions and tools available will enable the GDP to produce images suitable for most uses. Taking close-up images in the mouth can be challenging. Through digital imaging the exercise is easier and ultimately more achievable.

Clinical Relevance: The production of clear clinical images is a good means of patient communication and recording conditions and results.

GETTING STARTED

Camera Functions
Digital cameras with good macro capability such as Nikon Coolpix are essential for producing intra-oral images. Set on ‘auto’ virtually everything is set for you; framing the image and pressing the shutter release button is left to the user. However, to get the best images from digital cameras, it is necessary to make use of the ‘manual’ functions that are available.

When a digital image is taken, three settings determine the result:

- Exposure (the amount of light allowed to enter the camera through the lens);
- Resolution (the quality of the result in terms of definition); and
- Focus (the sharpness of the image).

Exposure
Determined by a combination of shutter speed, aperture and, on digital cameras, sensitivity (sensitivity in 35 mm terms is regulated by film speed or ISO, for instance Kodak Gold 200 (ISO) would be less sensitive to light than Gold 400, therefore Gold 400 would be better in lower light conditions). Sensitivity on digital cameras is also set as an ISO setting, 100 ISO being the default setting for most digital cameras.

Resolution
Maximum resolution is determined by the image capture chip (CCD) used to record a digital image; a 4 megapixel camera will produce a higher resolution image than a 2 megapixel camera on its maximum setting. All digital cameras will have the ability to produce images at varying resolutions up to a maximum determined by the CCD resolution.

Focus
Maximum sharpness over the whole image is the aim for clinical images. With close-up imaging this is difficult to achieve because of the small ‘depth of field (focus)’ when the lens is close to the subject.

Using ‘Manual’ Settings
Exposure/sensitivity, resolution and focus can all be manually set on cameras such as the Nikon Coolpix 4500. The author has used this camera as an example throughout the articles. Please remember different makes and models will vary in facilities and operation. The settings used may also be named differently on other makes.

Figure 1. Mode button and thumbwheel on the Nikon Coolpix 4500.

Figure 2. Setting of choice for optimum intra-oral images.
Digital cameras generally have four main programmable functions, these being:

- **Programme**
- **Aperture Priority**
- **Shutter Priority**
- **Manual**

**Programme**
The camera electronics make decisions for the user in respect of choice and combination of shutter and aperture, to achieve correct exposure.

**Aperture Priority**
The user determines the aperture (lens opening) used and the camera automatically selects the appropriate shutter speed. ‘Aperture priority’ is selected using the mode button and thumbwheel on the Nikon Coolpix 4500 (Figure 1).

The options are from about f3 to f10: f3 relates to a large aperture (lens opening) and therefore allows more light to enter the camera; f10 is a much smaller lens opening and allows less light to enter the camera.

The setting of choice, for intra-oral imaging, would be the largest number the user can set. For the Nikon Coolpix 4500 this is around f10 (Figure 2).

The reason for choosing the largest number (smallest aperture) is that, ‘Depth of field (focus)’ at close working distances is critical; a smaller aperture (f10) (larger number) gives you more ‘depth’ and your images will be sharper overall than if taken at a larger ‘lens opening’ (f3). Figure 3 shows an example of the ‘depth of focus’ effect of using smaller or larger ‘f’ numbers. (Figure 3b has more ‘depth’ owing to the small aperture (large number) being used.)

In ‘general imaging’ there is a necessary trade-off between aperture and shutter speed. Correct exposure is achieved by a combination of these. For instance, if the correct exposure for a subject was 1/250th of a second with an aperture of f3, and the user wanted to use an aperture of f10 to get extra depth of focus, this would necessitate the use of a slower shutter speed in the region of 1/60th to balance the exposure correctly.

When using flash and ‘aperture priority’ for close-up images, shutter speed need not be a concern, owing to the intensity of the flash. This is automatically set by the camera.

**Shutter Priority**
The user determines the shutter speed used and the camera automatically sets the appropriate ‘aperture’. For the purpose of ‘intra-oral’ imaging using flash, we would not need to use this recording mode. Use of this is covered in the final article.

**Other Manual Settings**

**Sensitivity**
Equivalent to ISO or ‘speed’ ratings on film, these can be set manually. On the 4500 the range is equivalent to 100–800 ISO (see ‘Exposure’). Setting on ‘auto’ sensitivity will be adjusted according to the level of light available. In general, this is the setting of choice.

**Image Quality**
Image quality settings the user can select on Nikon cameras are Hi, Fine, Normal and Basic as defined in the first article. The only time the user may want to select the ‘Hi’ (Tiff file) setting, would be for the production of an A2+ large format print. The user should experiment with these settings to find the level of quality required. The author would suggest that, for most applications, ‘Normal’ or ‘Fine’ would be the settings of choice (Figure 2).

**BEFORE YOU START**
The user should set the camera to switch off automatically after 30 seconds (see the first article). This will minimize the drain on batteries, especially when taking a whole series of test images (Figure 4).

Before taking intra-oral images, setting the camera up as described here...
DIGITAL PHOTOGRAPHY

DIGITAL PHOTOGRAPHY will save time. Good digital cameras will have some method of saving settings for a user, though saveable settings are limited. The author recommends you make use of this facility. The Nikon Coolpix 4500 gives you three ‘user settings’. These will save settings for:
- white balance; metering, single or continuous shot; image adjustment; saturation control; image sharpening and lens type.

The author recommends the user initially sets, and saves, the following for ‘Intra-oral’ imaging:
- Auto white balance (adjusts the white balance to suit lighting conditions);
- Centre weighted metering (measures light in entire frame but assigns a weight of 80% to area in centre of frame occupying roughly 2/3 of total);
- Single shot setting (most cameras will give you the option of continuous shooting, the camera records a low resolution image to achieve this);
- Auto image adjustment (adjusts brightness and contrast according to shooting conditions);
- Saturation control ‘normal’ (this controls the depth of colour in your image and for most instances best results will be achieved on the ‘normal’ setting);
- Image sharpness ‘normal’;
- Lens ‘normal’ (unless you have supplementary lenses fitted).

Other settings which cannot be saved as ‘User settings’ on the 4500, but should be set are:
- ‘Aperture Priority’ to largest ‘F’ number and of course the user will need to:
- Set the camera to ‘macro’;
- Focus zones if available should be set (Figure 5). The user can access this option via the ‘Shooting Menu’ on the 4500 and should be set on ‘AF Area Mode’ ‘Manual’ (focus zones give the user control over the area the autofocus system focuses on);
- The user should begin with the quality setting ‘normal’. This should be of a high enough quality for most uses.

INTRA-ORAL TECHNIQUE

The author suggests taking a number of random test shots (using the ‘macro’ setting) before taking images of a patient. Explore the menu settings and familiarize yourself with the controls and functions. Take as many images as you need, the only cost is time! The user should have no concern of ‘messing’ up the original settings, as there should always be a reset button!

Anterior and Lateral Views

These are the easiest views to achieve consistent results, and should be the view of choice to practise on a patient. With a ‘pop-up’ flash type camera, the ‘zoom’ should be on its maximum telephoto setting (not digital zoom, see first article) to achieve evenly lit results (Figure 6). For maximum close-up, Nikon recommend the middle zoom range. This will give closer magnification though there will be more pronounced shadowing from the flash (Figure 7). Set the ‘Auto Focus Area Mode’ option (Figure 5). Focus for anterior views should be made using either the left or right marker. It is worth remembering that one-third in front and two-thirds behind the point you focus on will be in acceptably sharp focus (Figure 3); the depth of these thirds will be determined mainly by distance from camera to subject and aperture. Use lip retractors wherever possible.

Lateral views are not quite as easy but with practice can be. Again, use lip retractors to get the best results with lateral views. Ease pressure on the

Figure 6: Evenly lit image with ‘pop-up’ flash and maximum telephoto zoom.

Figure 7: Shadow from ‘pop-up’ flash.

Figure 8. Lateral view taken on full telephoto zoom to give even distribution of light with little shadowing.

Figure 9. Example of a ‘burnt out’ image. This can be corrected when using the Nikon Coolpix 4500 by adjusting the flash output.

Figure 10. The rotating body of the 4500 makes it ideal for those difficult mirror views.
retractor furthest from the camera while increasing the ‘pull’ on the other. This will give the best retraction for the side of the mouth being photographed. In most cases, the centre focus zone will give the best ‘depth’, but try them out and see what suits your positioning best. Using maximum telephoto zoom to distribute the flash light falling on the subject works for lateral views as well (Figure 8). If harsh shadowing is a problem with lateral views, try changing the position of the flash relative to the subject by rotating the camera.

One of the commonest problems encountered with ‘close-up’ imaging is ‘burnt out’ images (Figure 9). To correct this, aperture settings can be changed, though the user should already have the camera set on the largest f number (Figure 2). For the sake of simplicity, the author would suggest moving further back from the subject. This will lessen the intensity of the flash. However, this will not give the user as close an image, but the image can be ‘cropped’ to the desired area on the computer later. In this case, the user would be effectively discarding part of the image and ‘enlarging’ the remainder. The resultant image will not be as high ‘resolution’ as the original, though often this will be acceptable. To offset the loss of resolution, the user, who routinely captures images at ‘normal’ image quality, could capture the image on ‘high’ setting instead, thus making up for the lost resolution when ‘cropped’.

The 4500 has the option to control the output of the flash. This would correct ‘burnt out’ images. High flash intensity is the main cause of ‘burnt out’ images. The ability to control flash output firmly sets this camera as the best choice in its class for intra-oral digital imaging.

Detail from images that are too dense is often recoverable. ‘Burnt out’ images have little recoverable detail in the highlight areas.

Unless using a ‘ring flash’, some shadowing is inevitable. As mentioned above, position of the shadowing can be controlled by rotating the camera to locate the flash in different positions relative to the view being taken.

**Occlusal Views**

As was the case with conventional 35 mm photography, occlusal views using mirrors are more difficult to master. Cameras such as the Nikon Coolpix 4500 with a rotating body (Figure 10) have an advantage, with the ability to rotate the lens to give an easier viewing position. Again, the same settings apply as with anterior views, making use of ‘aperture priority’ and focus zones. For occlusal views, the top and bottom zones are most useful (Figure 5). Positioning is a major factor and should be considered if problems with shadowing or focusing are encountered (Figure 11).

Use of retractors and mirrors are essential for best access. Accessibility varies, so it is well worth investing in at least a couple of sizes of retractors and mirrors. Mirrors in particular are not cheap but, with care, can last many years.

Wherever possible aim to capture an ideal image every time. This would involve little or no post capture manipulation. Taking 20–30 images in one day, and then spending even as little as 5 minutes ‘tidying’ those images, is going to be a constraining factor. An ideal image will not, however, always be possible, for instance the common problem of ‘burnt out’ images and the suggested ‘easy’ solution to move away from the subject, will involve post image ‘cropping’ on the computer to restore the original magnification.

When working on your image file always re-save the modified file as a copy and retain the original. Each time a file is resaved as a jpg it is compressed. This will gradually degrade the quality of the image.

**PRINTING YOUR IMAGES**

With the rapid rise in popularity of digital imaging, high street photographic outlets have responded to the demand and now offer colour printing from your files at reasonable costs. Online printing services are also growing in popularity and the quality and service from both are excellent. Facilities for cropping or enhancing your images are usually available.

If the user has a colour printer and wants to print his/her own images, this is not a problem, though the results may not be have the longevity of those printed commercially.

With the use of a word processing package such as Microsoft Word, images can be inserted into either a blank document, or a document with text. Once inserted, the image can be
DIGITAL PHOTOGRAPHY

Table 1. Recommended initial camera settings for intra-oral imaging.

Camera on ‘Macro’
‘Aperture Priority’ set on largest ‘f’ number (Figure 2)
Quality setting on ‘Normal’ or ‘High’ (Figure 2)
Set ‘zoom’ on maximum telephoto (not ‘digital zoom’) (Figure 6)
Focus zones if available (Figure 5)
Auto white balance
Centre weighted metering
Image adjustment ‘Auto’

Remember, best results are usually achieved when using manufacturers’ recommended inks, paper and settings.

CONCLUSION
Quality intra-oral digital images are achievable by the whole dental team, provided manual settings (Table 1) are applied and used to correct known problems. A digital camera can be an effective tool in and out of the workplace. Whatever your use of the images, they are cheap to take and easy to store. Once you have made the initial familiarization with your camera, I’m sure, like me, you’ll be hooked!

The author would recommend users visit http://www.dentistry.bham.ac.uk/photoforum for regular updates and camera recommendations.

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FURTHER READING
The Nikon Guide to Digital Photography with the Coolpix 4500.

WEBSITES
http://www.dcresource.com
http://www.photo.net
http://www.fujifilm.co.uk
http://www.nikon.co.uk
http://megapixel.net

BOOK REVIEW

This book is a comprehensive guide to oral and maxillofacial medicine in a compact and very readable format. The material is presented in a way that allows different approaches to the study of oral medicine. The first section is a concise summary of the fundamental principles of patient management. Section 2 covers common complaints and includes differential diagnoses, investigations and treatment. Section 3 discusses common and important oral conditions. Section 4 contains brief summaries of many conditions relevant to oral medicine and section 5 contains chapters on HIV and iatrogenic diseases. There are two useful and comprehensive appendices on the oral manifestations of disorders of specific systems and on agents used in the treatment of patients with oral diseases.

The layout makes the book easy to read, with heavy use of tables, diagrams and flow charts. These make the information easily accessible and understood by students, but retain the degree of detail that is relevant for readers with more experience of oral medicine. The inclusion of patient information sheets is novel and is particularly helpful for non-specialists. The appendix on agents used in the treatment of oral diseases includes comments and contra-indications, and is a good adjunct to the chapters on individual conditions where flow charts of treatment options help distinguish commonly prescribed therapies from those reserved for more severe cases. The explanations of the management of many complaints and conditions include the importance of psychosocial and lifestyle factors, as well as the role of habits.

At the start of the first chapter, the author quotes Sir William Osler, ‘It is better to know what kind of patient has the disease than what kind of disease the patient has’. This philosophy obviously informs the author’s approach in this book. This book should be a recommended reference text for undergraduate and postgraduate dental students but will also achieve wide appeal among oral medicine specialists and interested general dental practitioners.

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