

Close-up digital photography in dentistry

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The importance of close-up dental photography

- Clinical photographs form a part of the patient's clinical record. This is particularly helpful for the dentist because it helps to plan treatment and reminds both the dentist and patient of where they started from. If clinical photographs were taken before every irreversible and invasive procedure some potential disagreements between patients and their dentist might be avoided, as patients can easily forget how their teeth and gums were in the first place. An example of how clinical photographs can form an invaluable record is when a patient has decided to have his or her teeth whitened. By taking a photograph with the initial shade-tab in the shot and comparing it with a similar shot at the end of the treatment, valuable proof of whitening is recorded.
- Clinical photographs can be used to communicate to your technician.
- Clinical photographs are a powerful tool to demonstrate to patients what might be achieved by illustrating a similar case and its outcome to a patient.
- Photographs can be used for marketing purposes on brochures and on websites.
- They can be used for learning and teaching. They form a valuable self-check.
- Photographs of trauma cases form an important record but written consent must be obtained from the patient or a relative if the patient is incapable of providing consent themselves. In cases of suspected child abuse photographs should be taken. No consent is required to take photographs in the case of suspected child abuse.
- Photographs (along with a mm scale) should be taken of a pathological lesion.

A brief history

The photographic image dates back to 1839 when two processes were developed simultaneously. In France, Louis-Jacques-Mandé Daguerre used a silver coated copper plate to make a one-off image whilst in England William Henry Fox Talbot developed a paper-based negative/positive process, which allowed him to make multiple prints from the one negative.

The two fundamental principles used by both Daguerre and Fox Talbot were the reaction of certain chemical compounds to light, and the creation of an image when light passes through an aperture in a dark box.

Film-based cameras were the mainstay for many years, but 1969 saw the development of the charged coupling device (CCD). It was built into the first video camera by George Smith and Willard Boyle, and in 1973 Steven Sasson used a CCD to produce a still digital image. This early digital camera weighed eight pounds and had only 0.1 megapixels. Modern cameras frequently have 10 or more megapixel sensors. 1988 saw the launch of the first commercial all-digital camera, the Fuji DS1P.

Early digital cameras stored their images on a floppy disc. They had a limited storage capacity of less than one megabyte. Since these early days there have been steady improvements in sensors, and storage devices.

Ethical aspects

Respect for patient autonomy is one of the central ethical principles in medical practice. There are two ethical implications for medical images: patient consent and patient confidentiality. Images taken in the medical context, just like the information that a patient gives a doctor, form part of the patient's confidential clinical records and therefore should be treated in exactly the same way. Their clinical photographs must comply with the Data Protection Act of 1998. Correct storage of digital clinical photographs to comply with The Data Protection Act must also be considered.

BMA and GMC guidelines state that a patient must be given as much information as possible on where an image might be used. Three levels of consent must be considered:

- 1) For use by appropriate professionals within a given establishment
- 2) For the use in lectures and teaching
- 3) For medical publication in hard copy or on the internet.

It must be made clear to a patient that once their clinical image is published that it is impossible to withdraw their consent because it is in the public domain.

The issue of patient recognisability in clinical photographs is also important. Simply blacking out a patient's eyes probably does not adequately disguise their identity. In many clinical photographs identification of the patient is highly unlikely, but even so, consent from the patient is still necessary and the patient has the right to deny its publication. Informed consent for publication requires that the patient should be shown the

manuscript to be published.

Sensors

Film cameras use a light sensitive film to capture and store a negative image, which can then be printed.

Digital cameras use a sensor. The sensor is a silicon chip that contains millions of photosensitive diodes called photosites or pixels. When the camera shutter opens, each photosite records the brightness of light falling on it. The brightness is recorded as a set of numbers that can be used to set the colour and brightness of dots on the screen, or ink on the printed page in order to reconstruct the image.

CMOS sensors are a high quality sensor used in digital photography. They use less power than other sensors and produce less heat and make less noise.

The size of the sensor is also important. Squeezing too many pixels onto a small sensor can mean that a lens will not be able to resolve (separate out) all of the pixels. If the sensor is smaller than a 35mm film size it will increase the focal length of the lens, typically by a factor of 1.4 to 1.6. For example, if a 100mm macro lens is fitted to a digital body with a sensor multiplication factor of 1.5 will increase the focal length to 150mm. (see Figures 1a-b)

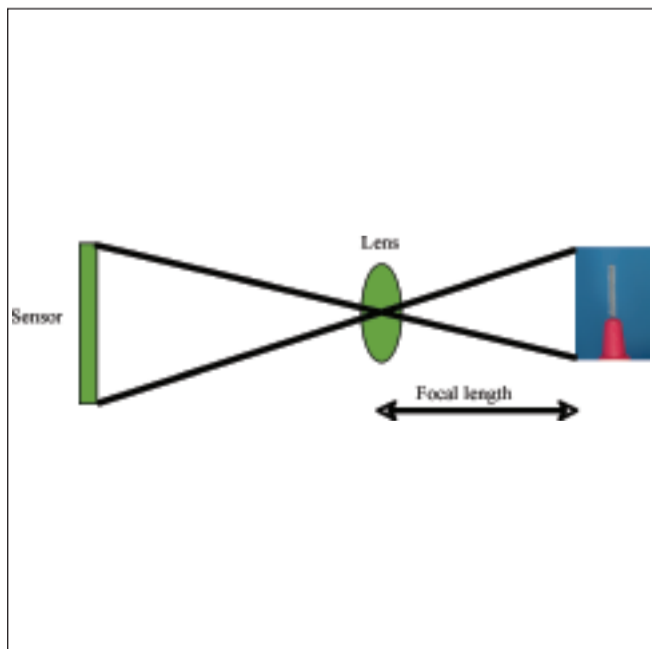
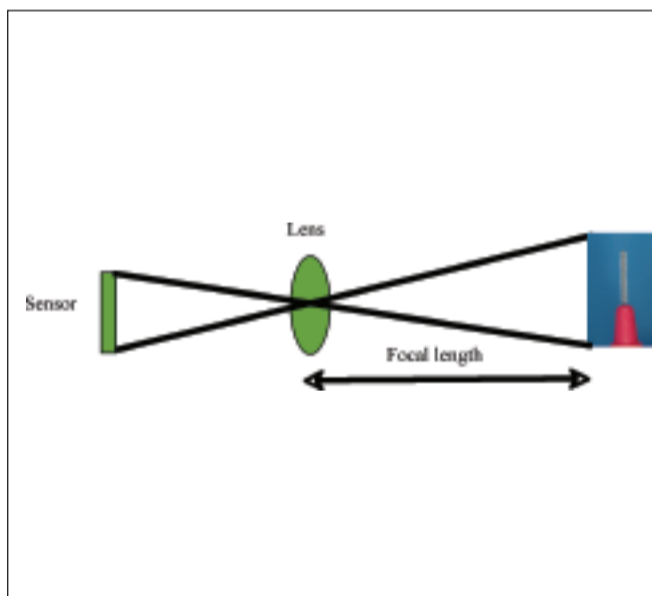


Figure 1a and 1b

Storage devices

Modern digital cameras use memory cards to store the images in the camera. The memory cards can then be used to transfer the images to a computer or directly to a printer. Popular types of memory cards used in cameras are the compact flash card and the secure digital (SD) card.

The memory card can be read directly from the camera via a USB linkage between the camera and computer. Alternatively, the card can be removed from the camera and be read by a card

reader, which will also connect to the computer via a USB linkage. Some computers have built in card readers.

A one-gigabyte (GB) memory card will give you ample storage for the purpose of clinical photography.

Choosing a camera system

A single lens reflex camera is most suited to close-up dental photography. The principal reason for choosing a single lens reflex camera (SLR) is that what you see in the viewfinder will be the exact image that appears on the screen. This is not the case with other range finder cameras.

It is not necessary to buy the most expensive SLR camera body offered by a manufacturer but Canon and Nikon have the most comprehensive range of close-up and macro accessories available. Many of the mid range SLR camera bodies are now offering up to ten million pixel sensors. This is more than ade-

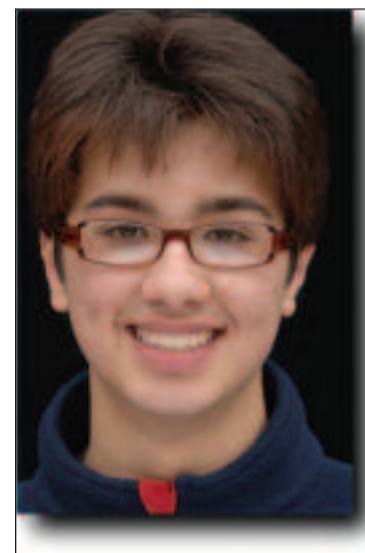


Figure 2a



Figure 2b



Figure 2c



Figure 3



Figure 4



Figure 5

quate.

Shutter lag is an annoying feature of cheaper cameras. This is the delay in taking the picture even though you have pushed down the shutter release button. Minimal shutter lag is a feature to look for when buying a digital SLR body.

Other features to look out for include:

- The size and brightness of the rear screen will allow you to check the composition and exposure of your shot
- The weight of the camera should not put you off. In many ways a heavier camera is easier to stabilise
- A viewfinder diopter is useful if you wear glasses. The viewfinder can be corrected to allow you to use the camera without your glasses. Another very useful feature of a viewfinder is to have a grid visible. This helps compose your shot and align the occlusal plane
- If you are taking a lot of shots a lithium ion battery is worth considering. It is re-chargeable and has a long life
- The camera body should have a manual setting to allow the operator to control aperture and shutter speed
- Finally, the camera body should allow bracketing of exposures. This will enable you to take three pictures of each shot. The first picture will be at the exposure (aperture) that you have chosen. The second picture may be a little under exposed relative to the first picture taken; it will appear a little darker. The third picture will be a little over exposed relative to the first picture and will appear a little lighter. Bracketing thus allows you to take three slightly different exposures of the same shot and chose the one that best represents what you want to show or record. Another way to alter the exposure (brightness) of a shot is to use a digital software package to alter the image. Throughout this series of articles I will advise the reader not to rely on software to manipulate an image, which may form part of a clinical record.

Lens choice

If you have a limited budget then it is better to spend more of your money on a good lens rather than an expensive body, which may have features that you will not use in close up dental photography.

In clinical photography the following reproduction ratios are commonly used:

- 1:10 Portrait photography (see Figure 2)
- 1:2 Image of a set of teeth. Image on sensor is half life size (see Figure 3)
- 1:1 Front teeth canine to canine (usually only half of canine visible) (see Figure 4)
- 2:1 Two upper front teeth. Image on sensor is twice life size (see Figure 5).

Zoom lenses with a macro setting are not suitable because they have a maximum reproduction ratio of about 1:4.

Dedicated macro lenses are designed and corrected for close up photography. Macro lenses usually come in 50mm, 100mm and 200mm focal lengths – 100mm is ideal for macro photography. At 50mm you would be too close to your subject and at 200 mm you would be too far away and the flashgun would be less effective.

The macro lens you use should have a small aperture to maximise the depth of field. An aperture or f-stop of 32 is ideal for dental photography because many shots require a significant depth of field.

Some macro lenses feature image-stabilising technology. This is not strictly necessary in dental photography because a flash is used.

Most clinical photography is performed using manual focusing because this allows the photographer to standardise reproduction ratios.

Flashguns

Nearly all dental photography uses flash. The advantages of flash photography are:

- Fast shutter speeds are used which eliminate camera shake
- The light intensity is high allowing the use of small apertures
- The heat generation is minimal which increases patient comfort
- A ring flash is ideal for clinical photography because the source of light is close to the lens. This will eliminate any potential shadow from the cheeks and lips. The ring flash also gives a very even illumination with minimal shadow. This is ideal in clinical photography.

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Glossary

Depth of field: This is the ability of the areas in front of and behind the main subject to field remain in focus. Three things effect the depth of field: focal length of the lens, aperture and distance from the subject. A larger aperture (f-stop number) will render a shallower depth of field. A longer focal-length lens will also give a narrower depth of field. Finally, the closer the camera is to a subject the narrower the depth of field will be.

USB (Universal Serial Bus): This is a hardware standard for connecting peripheral devices to computers. The current version of USB is USB2.0.

Noise: In digital photography this refers to areas of an image where a multi-coloured confetti appearance is observed. This is particularly noticeable in the dark areas of a picture. Noise increases as the ISO setting of the camera increases.

CMOS: Complementary metal oxide semiconductor. ■