

Digital photography in orthodontics

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Abstract

The buzzword today is digital. Be it music, T.V., video, watch, diary or any appliance. The world is going digital. Film less photography, pictures on a chip, call it what, this is a new phenomenon of technology. It is big, and it is the way things will be from this day forwards. For over 160 years, photography has been based on the silver halide film, which is now being replaced. Digital photography has come about as a result of convergence of both IT and photography. And it has so much to offer us. This article reviews the possibilities of digital photography in orthodontics.

Keywords: Cameras; Clinical; Digital; Orthodontics; Photography

1. Introduction

The complete process by which pictures are made by the chemical action of light on a sensitized plate or film is known as photography. Photography in dentistry has made some change and progress since 1968. Photographic information about the health professional has little or no standard. Quality photography involves "making photographs." From the orthodontic point of view, photographs have become an essential state of the art diagnostic tool with numerous added advantages.

Without proper knowledge or proper equipment, it is almost impossible to produce quality results. The 35-mm camera from 1925 through 1940 permitted non photographers to photograph intra-oral black-and-white views. When color slide film came into the market, color slides of scientific and clinical views were photographed.

Before the 35m camera, few interiorly views were made. Those views were poor for many reasons. Cameras were too large and not easy to hold by hand. Films were slow, and exposures could be long. It was almost impossible to illuminate the oral cavity properly. With small flash bulbs and later electronic flash units, some of their problems could be corrected. One of the greatest problems was the use of the wrong focal length lenses. The most earliest scientific photography was used in medicine and consisted of exterior views. Of the early dental intra-oral views, dating from about 1920, all have been poor because the perspective to the image was distorted owing to the use of the wrong lens.

To those professional people today wanting to make quality photographic records of cases, say is that with the proper equipment, good visualization, and a little experience you can have results equal to those made by a scientific photographer.

In photography, color temperature gives us a correct indication of the color composition of the light source, and it is measured in degrees Kelvin. Broadly speaking, there are two light sources for photography – daylight and artificial light. Daylight is the largest available source of light for monochrome and color photography, and comparatively more pictures are taken in daylight. The quality

of daylight changes constantly from sunrise to sunset. For photographic purposes, this change of colors in daylight can be measured in terms of color temperature of daylight at sunrise is approximately 2800 degrees Kelvin. The same conditions occur in the case of artificial light sources except that artificial light has a greater quantity of red as compared to the other colors.

2. Why take orthodontic photographic records

Clinical photographs allow the orthodontist to carefully study the existing patient's Soft-tissue patterns during the treatment planning stage. To assess lip morphology and tonicity, the smile arc and smile esthetics from various angles, the degree of the incisal show upon smiling (McLaren et al 2001, Gallegos 2001). For purposes of research and publication, and for lecturing and teaching presentations and the growing importance to the need for such records for medico-legal reasons cannot be over emphasized. (Woodall 1993, Sandler 1997, Smith 2002). Thus, they allow us to study the patient in a so called "social" setting, and all without the patient ever being present.

Such information greatly aids the orthodontist in formulating the best possible treatment plan for each patient, and monitoring them in subsequent follow-ups. (Bengel 2000, Sandler 2001)

3. Why digital?

- One of the major reasons is the ease of use of such cameras, along with the ability to repeat / delete unsuitable images on the spot.
- There is no need to wait till the film is developed to check your photos. In digital photography any problems can be easily rectified immediately.
- Direct digital photography, which converts the images almost immediately into a digital file, has many beneficial advantages in dentistry, such as, one can see images almost immediately, allows for immediate retakes when needed.

- Can make 100% exact duplicates and media can be reused meaning no additional cost of film or its chemical processing; Single media can hold many images, ease of manipulation.
- These images can be easily stored, and catalogued images can be instantly forwarded or transmitted to interested parties, such as: patients, labs, colleagues, insurance carriers, and web pages among others.
- Another important advantage is the "Running Cost" issue. Digital camera setups are cost effective no more buying film, no more developing costs and hassles, and no more worries about where to store all the slides and "physical" photographs of your patients.
- The last advantage to mention here is the ability to enhance, or "post-process" your images. (Bengel 2000, Dunn et al 2000, Sandler 2001).

4. Types of digital cameras

- 1) Consumer point and shoot cameras :
 - Fully automatic
 - Have low resolution
 - 4 x 6 inches

Although these cameras may be adequate for small reproduction in newsletters or web pages, they won't meet the needs of professional photographers. This consumer – level cameras use small chips with striped arrays and have a limited range of tones and colors.

5. Prosumer cameras

- Based on the 35 mm model
- Have well over one million pixels. They usually have good features like macro mode, LCD screen and have a range finder like viewing system and not SLR model, hence generally; they cannot be used for serious clinical photography. The other major problems being the facility to use additional systems like the ring flash.(Sandler 2001)

6. Professional cameras

Professional class digital cameras are built on 35-mm camera bodies that use conventional interchange's lenses most are conversions of popular film cameras while a few are designed to be digital from the ground up.

They are called multi pixel camera as the big advantage of these cameras lies on the fact that they are SLR and hence accessories like macro lenses, ring flash, etc. can be used.

7. Disadvantages

- Most digital cameras suffer momentary delay from time. You push the button until the photo is captured and even longer delay until you can take the next photo due to memory write process. So not as quick and hence, no multiple rapid sessions – not for action photography.
 - Loses battery charge quickly especially with digital display.
 - Initial cost is heavier than similar film cameras.
 - In fact, by the time you get your camera home, chances are there will be some new – model in the market that is even better and possibly cheaper.

Digital imaging, one of the hot fields throughout the computer world, is attracting more and more interest among orthodontists. It is now possible, with a reasonable investment, to digitally acquire, archive, and easily retrieve clinical images of our patients.

- The hardware involved includes flatbed scanners, slide scanners, video cameras and still digital cameras. Digital cameras can be divided into two main groups: compact digi-

tal cameras and professional reflex cameras with digital interface.

- If your budget allows you to buy a professional reflex camera, it will certainly meet all the requirements for clinical orthodontic photography.
- The choice of a compact camera can be difficult, due to the wide range of quality and price.
- Many mistakes can be made in selecting the appropriate system for an orthodontic practice.

8. Some of the important aspects to be considered while selecting cameras include

- 1) Autofocus speed and precision :

It is important to test the autofocus of a camera, taking into account the magnification ratio, distance from the subject, and illumination. Since the autofocus might not work properly under some orthodontic conditions, the availability of a manual focus is a plus.

A satisfactory autofocus for orthodontic purposes will work properly at a distance of 12" from the subject with a 1:2 magnification ratio.

- 2) CCD resolution and quality :

In digital photography, traditional film is replaced by a charged coupled Device. A CCD sensor has thousands of light detectors, called "Pixels", on its surface. A high number of pixels ("Optical resolution") increases the quality and detail of the image, but also increases the size of the file in which the image will be saved.

File resolution can be increased by a software interpolation, which does not actually improve the image quality. Therefore, when evaluating a camera's optical resolution, the interpolation resolution should not be considered, but only the actual CCD optical resolution.

Some digital cameras allow an image to be captured at two or more different resolutions: the highest is the full CCD resolution, but the lower resolutions use only a portion of the CCD pixels to describe the image. This division can save file space if the CCD has a high optical resolution.

High resolution can only be used to full advantage when nothing extraneous to the required area is captured in the frame an intraoral picture taken with a resolution of 832 x 624 meanings that about 520,000 pixels are used to describe the subject. However, the clinically useful area (shown by the yellow rectangle) is displayed by only 212,000 pixels. If this image has been taken as the maximum possible magnification for the camera, then the latter number represents the "Clinically useful resolution" (CUR) for this camera.

The CUR a key factor in the choice of digital cameras, depends on both the sensor resolution and the quality of the optical lens system. A new generation of compact digital cameras with sensor resolutions of as many as 1,000,000 pixels are now on the market, but they have poor optical systems that diminish their CUR. The CUR also depends on the needs of the user. If you want to photograph dental crown anatomy in detail, you will need a high CCD resolution and / or a powerful lens system.

A CUR of about 400,000 pixels should be adequate for orthodontic use. We recommended selecting a camera with a CCD resolution close to the CUR. Too great a difference will produce unnecessarily large files and thus will require more memory and a longer transfer time at the computer. If the CCD resolution is much larger than the CUR, it will be necessary to manipulate (crop) each file in the computer to avoid archiving unwanted information.

The sensor quality of a single pixel in transmitting the luminance (brightness) and chrominance (color hue) of the light signal should be tested by observing the images captured by the digital camera on a properly tuned monitor. Some CCDs show a minor shift in hue toward one of the base colors (red, green, or blue). In our opinion, this problem has a limited impact on image quality, since it can be easily corrected with any imaging software. (Woodall

1993, Bengel 2000, McLaren et al 2001, Gallegos 2001, Sandler 2001, Smith 2002)

3) Flash capability :

In conventional dental photography, a synchronized ring flash is needed to obtain uniform illumination of the subject in macro mode. External light sources cannot be used, because the lips and chin, the camera, and the operator (who is close to the subject) will create shadows.

Most compact digital cameras have built – in flash units on one side of the lens. Which will produce uneven light distribution in intraoral photography and have no ports for external synchronized flash unit. Even a camera with a connection for a synchronized flash may not allow the use of a ring flash, because it will cover the autofocus sensor. The ability to use a ring flash is therefore an important point in selecting a digital camera.

If your camera does not permit the use of a ring flash, the subject illumination can be improved in two ways :

- 1) Light deflectors a mirror system can effectively diffuse the flash light on both sides of the subject. Light deflectors for some digital camera models are currently on the market.
- 2) Light – activated external flash. It may be possible to mount an external flash on the opposite side of the built – in flash. The two flashes will operate simultaneously, producing good illumination of the subject without shadows.
- 4) Viewfinder :

An optical reflex viewfinder is ideal, because it provides an almost perfect correspondence between the image seen in the viewfinder and the captured image under all conditions.

An alternative is a liquid crystal display viewfinder. The LCD can be as small as 5" in which case an optical system allows proper magnification with the eye in close contact with the viewfinder, as with most video cameras. An LCD can also be a small screen, 1.5 – 2.5" in diameter, in which case the camera must be held away from the eye when shooting most LCDs has a low "refresh rate," meaning that as the camera is moved to frame the best picture, the image in the viewfinder changes jerkily. Other disadvantages are that an LCD is hard to read in bright sunlight, and that a large unit consumes a great deal of battery power.

Digital cameras with Galilean viewfinders are difficult to use, because in macro photography, the area framed by the viewfinder will be quite different from the one framed by the lens.

9. Tuning of exposition parameters

In macro photography, it is important to be able to manually adjust the exposition parameters: the size of the lens opening (aperture), indicated by the f-number, and the shutter speed measured in fractions of a second. It is often difficult for the automatic mechanism to function properly at close distances, particularly if the flash is used, as is often the case with intraoral photography.

10. Batteries and AC connection

Some digital cameras use ordinary alkaline batteries and have a battery life of only 10-15 photographs. Others have rechargeable batteries that can last through more pictures. If your digital camera comes with two rechargeable batteries, you will never experience the "no battery" situation.

An external AC connection can be helpful even if it is not used routinely. The power cord tends to interfere with operator movement, and a socket must be available nearby.

11. File format and software compression

Once an image has been acquired by the CCD, it is stored in the camera's memory as a file. Image files can be of different formats and more important, can be compressed. Compression increases the number of images that can be stored in memory, but it also

causes a decay of the image quality; the higher the compression, the greater the decay.

A good feature is the ability to choose whether the images are to be saved with or without compression, and at which compression level. This is usually done by selection the capture mode as "FINE". "NORMAL" or "ECONOMY" (the terms may vary depending on the camera model).

The file storage format is not critical, but it is preferable to use digital cameras that save the acquired images as JPEG or TIFF files, which can be read by virtually any imaging software. Proprietary file formats will require special software.

12. Number of images stored in memory

There are two types of image storage: built – in (internal) memory and removable memory. Digital cameras with only internal memory should be avoided. Removable memory is like a conventional roll of film that can be used over and over again. Four types of removable memory are currently available for digital cameras:

- Solid-state floppy disk card (SSFDC) or "smart card."
- Miniature card
- Compact flash card
- 3.5" floppy disk

SSFDCs can store only as much as 8 MB of data, while miniature cards store as much as 24 MB. These two media need a converter that is inserted in a floppy disk or PCMCIA drive.

Compact flash cards can be found in sizes from 2MB to more than 100 MB and donot need an adapter for insertion in a PCMCIA drive. Floppy disks are inexpensive and easy to use, but have a storage capacity of only 1.4 MB.

13. Speed to transfer to computer

All images stored in the digital camera's memory are eventually transferred into a computer for archiving. The time needed to transfer the images depends on two factors: the size of the image files and the transfer speed (in KB / second). Since the file dimension is determined by the resolution and compression to the image, a reduction in size will have a negative impact on image quality. Therefore, transfer speed is the key variable.

There are two different ways to transfer the images from the camera to the computer:

- 1) Cable connection. Most digital cameras can be connected to a PC or Macintosh computer through a serial or parallel port. This kind of connection is extremely slow, however, and serial transfer is slower than parallel. Some cameras can use a SCSI port, which is much faster, but not available on all PCs.
- 2) Transfer from removable memory through a computer device. This is probably the most convenient way to transfer the images to the computer.

If the digital camera uses compact flash cards, miniature cards, or SSFDCs, a PCMCIA drive is the method of choice. File transfer through a PCMCIA drive is extremely fast and easy.

14. Conclusion

Digital photography is one of the emerging trends in dentistry with numerous advantages. The right knowledge of technology and it application will allow the orthodontist to provide quality treatment, which will be acknowledged by the patients also. Awareness about the basics of dental photography will help the clinician to choose the right equipment suitable for their day to day practice.

This review article gives an overview about the increasing importance of digital photography in orthodontics and the various aspects an orthodontist to be aware of in this digital era.

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