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Digital Photography in Orthodontics

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Abstract *A brief history of digital photography is provided along with a critical appraisal of the 'prosumer' and professional systems currently available. Recommendations are made as to the system best suited to current orthodontic practice.*

Index words: Digital, Photography.

Introduction

Photographs are an essential part of clinical documentation. Current 'best practice' is a full set of extra- and intraoral photographs, both at the start and completion of a course of orthodontic treatment and, ideally, some mid-treatment photographs showing key-stages in treatment (Sandler, 2000).

Digital photography has been generally available since 1981. In 1991 'Autotrader' were the first mass market publication to move completely to digital recording of images. Now, many trades and professions, including estate agents, advertising agencies, police, and the media use digital photography on a routine basis.

Digital images are made up of picture elements ('pixels') comprising red, green, and blue light, each set at a level between 0 and 255. If all three colours are set at 255 white is the result, while if all are set at zero, black results (Figure 1). There are 256 grey shades that result from all three colours being set at the same number. Varying the level of each of the three colours results in the gamut of 16·7 million colours. Numerical values for each of these colours are stored on the Charged Couple device (CCD). This is made up of pixels, the number of which, combined with the degree of compression, determines the quality of the final output.

In the 1990s a typical CCD would comprise 640 × 480 pixels resulting in acceptable images for snapshots, but lacking the quality needed for high quality clinical photographs (Figure 2). By 1999 the first 'mega-pixel' cameras (over 1,000,000 pixels per image) were becoming available, but above 1·5 megapixels the law of diminishing returns kicked in with a disproportionate price increase for only modest improvements in quality.

Bearing in mind a conventional 35-mm slide is thought to contain the equivalent of 25–30 million pixels of information there was still a long way to go for digital images to be serious competition. In addition, conventional photographic equipment for orthodontic images produced good image quality, was very reliable and user-friendly (Sandler and Murray, 1999), and was relatively inexpensive.

However, well-recognized problems with conventional photographic techniques are the cost of developing and processing films, the time required for processing and physical storage of all the patients slides or prints.

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'Prosumer' cameras

One type of digital camera (prosumer) falls into the mid-range price bracket £500–1500 and lies between the consumer camera and the professional models. They usually have a host of useful features including macro-zoom lenses and potentially high image quality. The 'piece de resistance' of digital cameras is undoubtedly the image preview facility in that images can be immediately viewed on the LCD screen and accepted or, if flawed, deleted and retaken.

The problems with the 'prosumer' cameras used for orthodontic photography are three-fold.

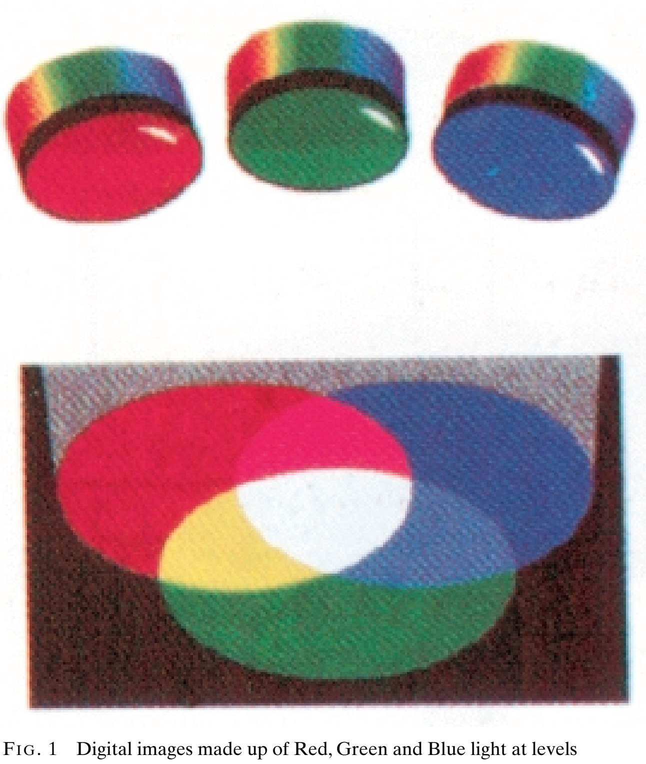

FIG. 1 Digital images made up of Red, Green and Blue light at levels between 0 and 255. 16·7 m colours in all.

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First, the flash provided with most digital cameras is a point flash. Experience has shown that for high quality intra-oral images ring flashes are essential to avoid unacceptable shadowing on most of the images (Figure 3). Despite the use of deflectors and diffusers the results with the built-in point flash tend to be disappointing. The point flashes are also not powerful enough to allow the photos to be taken on very small apertures (F32). This is essential as it greatly increases the depth of field and ensures most of the frame is in focus. In addition, even if it is possible to add a ring flash to the 'prosumer' camera high quality consistently exposed images require through the lens (TTL) metering, which is not available on these 'lower end' systems. After 20 years of ever increasing quality of orthodontic photography using SLR systems, TTL metering, and ring flashes, some of the orthodontic community are accepting mediocre photographs, taken with substandard digital equipment just for the facility of immediate viewing.

It is possible to overcome some of the shadowing problems of a point flash by modifying the technique used.

FIG. 2 Low pixel count (left) results in poorer quality image than required for orthodontics (right).

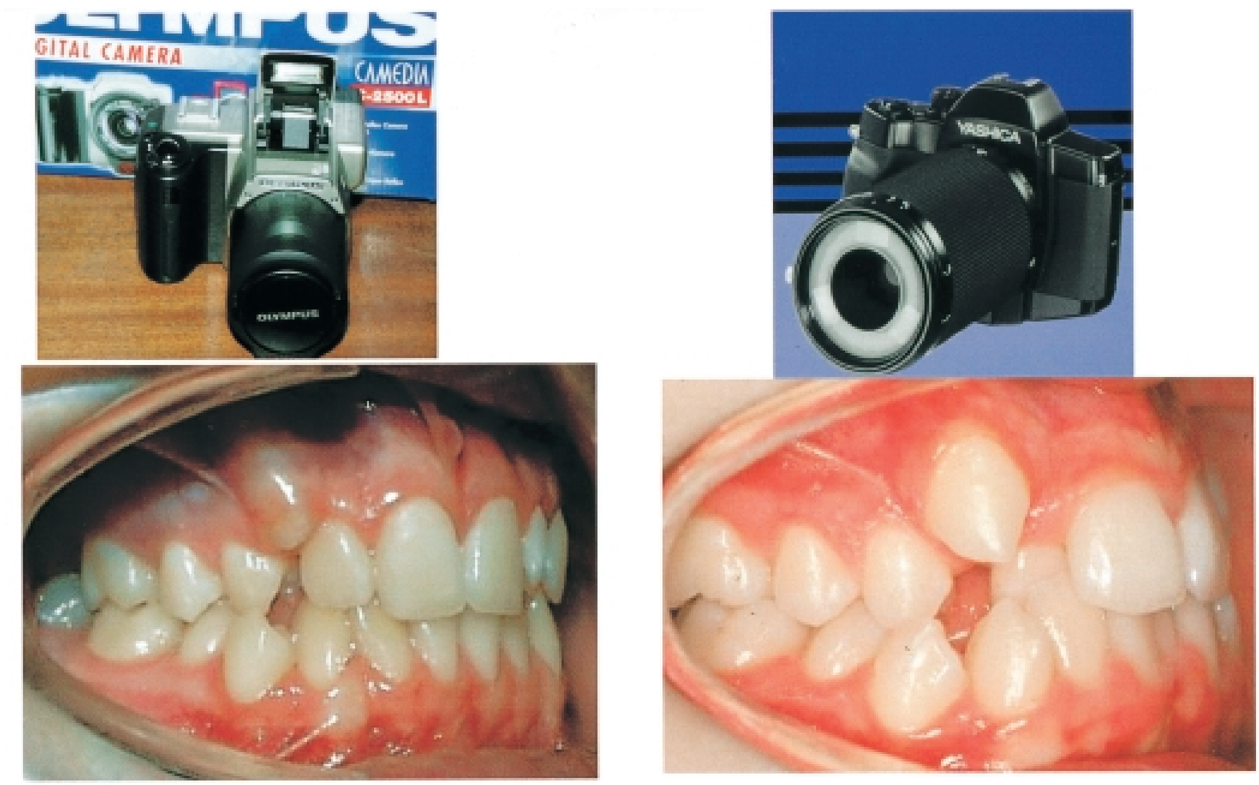

FIG. 3 Point flash intra-oral images are invariably inferior to ring flash due to shadowing and variable exposure.

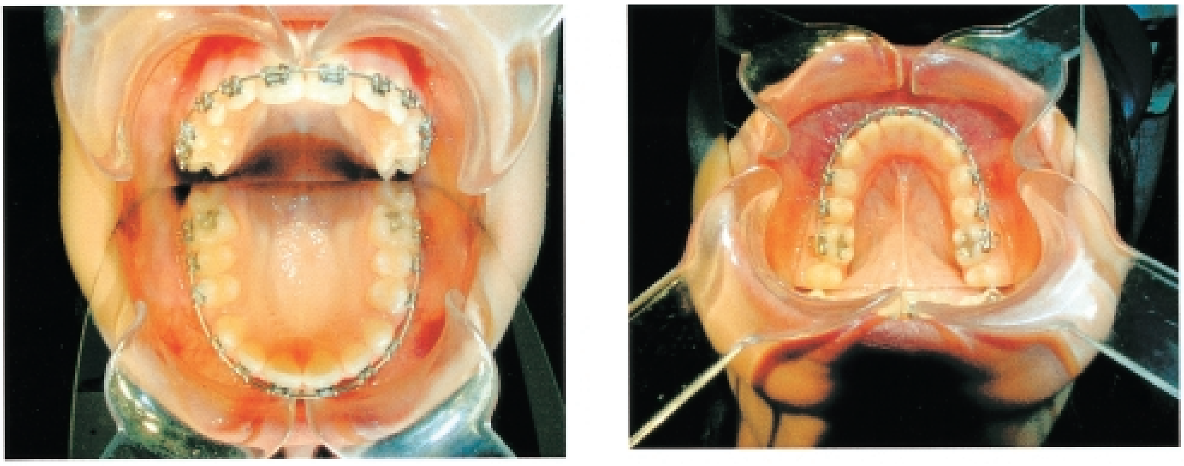

FIG. 4 Slightly different technique used for occlusal shots with point flash—shadows less but pixels wasted.

Taking the occlusal shots from much further away may ensure adequate illumination, but will inevitably waste pixels unnecessarily and focusing will also be problematic (Figure 4). Turning the camera around on buccal intra-oral shots may also reduce shadowing to a degree.

The second problem involves the viewfinders; some digital cameras are available with a 'Galilean telescope' viewfinder that is very suitable for snapshots, but totally unsuitable for high quality intra-oral photography. The problem is that the viewfinder, when close to the subject, doesn't accurately represent what the lens will 'see'. Live display on the LCD screen is also possible, but they are again inaccurate if the 'refresh rate' is slow, and are very power hungry, making it an unsuitable method unless a mains supply is utilized.

Thirdly, the focusing system can be problematic as the auto-focus systems on the 'prosumer' cameras are frustrating to work with when capturing intra-oral photographs. They often take three or four attempts to get the system to focus adequately, and all the area of interest is not always as sharp as it might be. The predetermined distance 'macro' settings available on some of the digital cameras also sometimes give disappointing results.

Professional cameras

Top end cameras have always been available. Indeed, Kodak teamed up with Nikon in the late 1990s to produce the Digital Camera System (DCS), which was capable of very high quality images. The problem with this system was that the camera body alone was over £10,000 (Figure 5).

The Nikon Dl is one of the best digital cameras and is the one used by a great many photojournalists worldwide. It has a vast array of features required by professionals, and the body is built out of titanium to an incredibly high specification, for use in sandstorms, typhoons, and war zones throughout the world. The problem with the Dl is that it is a very heavy camera and would be difficult to hold with one hand, a technique essential for high quality intra-oral images (Sandler and Murray, 1999). Also The SB29 ring flash does not work as TTL metering with this body. Finally,

FIG. 5 Basic price of Nikon/Kodak DCS £10,495 in March 1999.

a price tag for the whole package of close to £5000 makes it unaffordable for many clinicians.

Another digital camera recently released is the Fuji FinePix S1 Pro, which may be the perfect digital camera for orthodontics (Figure 6). The body is made by Nikon and is therefore built to a high specification. The lens system required is the Nikon 105 mm/2·8 AF Macro and the flash system is the Nikon SB29 Speedlight. The flash provides TTL metering and, therefore, the intra-oral photos taken at F32 are invariably perfectly exposed and in focus. The pictures are all taken on manual focus just by setting the lens adjustment for intra-oral shots, then moving backwards and forwards to focus. Using the 'limit' switch on the lens allows the same magnification to be set for all intra-oral photos, thus allowing direct comparability between photos.

Images may be stored on a 64 Mb storage card. The capacity of this card means that 330 images can be stored, using the lowest pixel setting (1440) and maximum compression, resulting in images of about 200 Kb. The quality of these images is more than acceptable for most clinical situations (Figure 7). The images can still be cropped and enlarged as necessary retaining sufficient detail for most situations.

The only adjustment the camera requires is from F32 to F11 for extra-oral shots and to switch off the flash bulb behind the patients head on the three-quarter and profile view to throw the shadow behind the head.

The system has been in use in the Orthodontic Departments of Manchester University and Chesterfield Royal Hospital with 13 postgraduates using the system on a daily basis since October 2000, and the system is working very well so far. Before October, monthly bills for developing and processing at Manchester were approximately around €390 per month. It was evident that the digital camera would pay for itself in a reasonably short time, after which the photography will be ‘free’.

Conclusions

Digital photography offers many advantages including:

(1) rapid turn-around;
(2) checkable exposure accuracy;
(3) no ageing of photos;
(4) dust and scratches are irrelevant;
(5) built in white balance;

FIG. 6 Fuji Si FinePix Pro plus Nikon SB29 flash.

FIG. 7 Top pictures with point flash and no TTL metering, bottom with FujiS1 Pro.

(6) immediate viewing;
(7) no film or processing costs;
(8) inexpensive storage;
(9) easy retrieval;
(10) duplication easy;
(11) transmission around the world in seconds is entirely feasible.

The second paper in this series will detail a system for storage, manipulation, presentation, and transmission of the clinical images.

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