Use of digital photography in the Case orthodontic clinic

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In 2002, the orthodontic clinic at Case Western Reserve University totally converted to digital photography. We want to share the learning curve during this transition with clinicians planning the same change. A system and a protocol were developed for this transition; they have been in use for over a year. This system allows the handling of digital cameras when there are more clinicians than cameras; it can be applied to various specialties or fields. (Am J Orthod Dentofacial Orthop 2004;126:381-5)

Digital photography offers numerous advantages over film systems, including rapid image production, easy and quick deletion of poor images, no need for film and its associated expenses, decreased cost for enlargement, ease of editing and image storage, improved communication, and effortless placement in presentations or publications.[1,2] For these reasons, there is a trend toward the use of digital imaging systems.

The Department of Orthodontics at Case Western Reserve University underwent a major technological change in July 1995 when we computerized the clinic. Suddenly, all appointments, patient information, diagnoses, and treatment plans were entered in a computer instead of handwritten on paper forms.

The next major change was the switch to digital photography in July 2002. This switch required a year of experiments and pilot studies to choose the hardware, the software, and a system that would be used for managing and storing digital data. This required extensive research and some failures along the way.

Before we switched to digital photography, each resident (4 are accepted per year) was required to buy a specific camera system. This system was carefully chosen by an author (G.R.W.) with specific requirements necessary for selection. A single-lens reflex camera body was necessary. This allowed accurate reproduction of the desired image because the image seen through the viewfinder is essentially the same image that is captured on the film. The camera and lens needed manual settings. The aperture (opening) of the lens could be adjusted for maximal depth of field for close-ups and manually readjusted for facial photographs. A through-the-lens system makes this adjustment reproducible and predictable. The lens needed to be capable of focusing from infinity to one to one without auxiliary lenses or tubes. Finally, the flash needed to be capable of a point light source for maximal definition and rendering of detail.

In their first week, the residents were taught how to take pictures and use their cameras. On average, we take 9 pictures per patient: 4 extraoral (frontal, smile, profile, and 45°) and 5 intraoral (frontal, left, right, maxilla, and mandible). Different views are added at the request of instructors. To increase the chances of getting good-quality and well-focused pictures, 2 of each view would be taken. Therefore, every time a patient needed photographs, 18 pictures were taken, or almost a 24-exposure roll per patient. This roll was picked up by a photo laboratory and returned in approximately a week. Occasionally, the slides would come back with less than acceptable pictures (the flash did not work, the camera moved during exposure, poor composition), and another photography session would have to be scheduled.

When digital cameras became available, we quickly recognized the advantage of previewing the pictures immediately. This reduced not only the risk of getting bad images, but also the time spent taking them (because duplicates would no longer be necessary). When this advantage was recognized, initially, the image quality of a digital picture was equivalent to slide images from a higher-end digital camera, but the price

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Supported in part by the American Association of Orthodontists Foundation, a Case Western Reserve University UCITE grant, and the Case Western Reserve University Orthodontic Alumni Foundation.
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Submitted, March 2004; revised and accepted, May 2004.
0889-5406/$30.00

doi:10.1016/j.ajodo.2004.05.018

Fig 1. Fuji FinePix S1 Pro (courtesy of http://www.dpreview.com).

of these cameras made them impractical for a group practice. Like everything in technology, digital cameras became better and less expensive over time.[4] But also like everything in technology, it is hard to know when this technology is standard enough so that your equipment will not become obsolete, unable to be upgraded, and therefore unusable.

The first digital camera that the department purchased was a Mavica FD-71 (Sony, Tokyo, Japan), which was soon replaced by the Mavica FD-81. An advantage of these models is that the image is automatically stored in a floppy disk. The disk could be opened in any computer without a card reader, and it could be added to a patient's chart. To further test this camera, in 1999, the department gave a Mavica FD-81 to every orthodontic clinical instructor (14), so that they could test it, use it in their offices, photograph interesting cases, and show the images in their weekly seminars. The floppy disks were certainly practical, but they also created some problems. There was the cost and availability of the disks. A floppy disk could get damaged, and data were lost. The camera's flash unit was inadequate, creating limited light and shadows. The zoom was part optical and part digital, yielding distortions. The camera's optical viewfinder created a parallax error, which means that, at relatively short subject distances, the viewfinder sees a different image than what is recorded on the sensor (or film). This is a major disadvantage compared with through-the-lens viewfinders, in which what you see is what you get.

In 2000, we consulted Washington Scientific Camera (Seattle, Wash). It had been the provider for our camera systems for many years and recommended, for the price range we had specified (under $2000), the Sony DSC 770. The camera came with a close-up diopter set and a ring flash. The photo quality was better. This was primarily due to almost twice the effective pixels (1.3 versus 0.74 million pixels in the Mavica system). However, the camera was somewhat complicated and not as user-friendly as a film camera, and it was not a through-the-lens camera. Consequently, the DSC 770 system was not ideal for our practice. It was still more complicated to learn how to take digital than slide pictures. With 4 new practitioners joining every year, user-friendly equipment was an important criterion.

Even though the systems tested were not perfect, they were used when quick availability of images was necessary. However, these digital systems could not totally replace the slide system because of the failure to meet the selection requirements outlined earlier and the inadequate image quality. Therefore, they were used only sporadically.

This changed in 2002 when we purchased the FinePix S1 system (Fuji Photo Film, Tokyo, Japan) (Fig 1). The FinePix S1[5] (Table I) allows us to use the

Table I. Fuji S1 technical specifications

Type	Digital SLR (body only)
Body	Based on Nikon F60 (N60)
Image size	3040 × 2016
Lower resolutions	2304 × 1536 1440 × 960
Image modes	JPEG: basic, normal, fine; TIFF: RGB, YC
Image ratio w:h	3:2 (ish)
CCD pixels	3.4 megapixels
CCD effective pixels	3.07 megapixels (processed to 6.13 megapixels)
CCD size	23.3 × 15.6 mm (APS sized SuperCCD)
CCD manufacturer	FujiFilm
Sensitivities	ISO 320, 400, 800, 1600
Lens mount	Nikon F mount
Focal length multiplier	1.5 × (eg, 28-mm lens is equiv. of 42 mm on S1 Pro)
Auto focus	TTL Phase detection with automatic AF assist lamp
AF servo modes	AF: Single or continuous Auto Focus servo; M: Manual
Manual focus	Yes, on lens
Metering modes	1. 3D 6-zone multi-pattern metering 2. 6-zone multi-pattern metering 3. Center-weighted average
White balance modes	Auto, sunny, shade, fluorescent 1, fluorescent 2, fluorescent 3, incandescent, and custom
Sharpening control	Original, normal, hard
Color control	Original, standard, high, black and white
Tone control	Original, standard, hard (controls contrast)
Min shutter	30 seconds
Max shutter	1/2000 sec
Accessory shoe	Hot shoe (flash contacts, TTL auto flash and ready light contacts)
Flash modes	Normal, red-eye reduction, red-eye reduction slow sync, slow sync
Exposure adjustment	−3EV to +3EV in 1/3EV steps
Aperture priority	Yes, full range
Shutter priority	Yes, full range
Full manual	Yes, full range
Continuous/burst	Yes, sports mode ~1.5 fps
Tripod mount	Yes
Self-timer	Yes, 2 or 10 seconds
Time-lapse recording	No
Video out	Yes, differs by region
Storage types	1. compact flash type I or II (up to 1 GB); 2. SmartMedia (up to 64MB)
Viewfinder	Optical, 90% vertical coverage, 93% horizontal
LCD	2.0″ 200,000 pixel
Playback zoom	Yes, up to 19.0 ×
Operating system	Proprietary
Connectivity	USB (download or shooting control)
Battery/charger	Yes, 4 × AA NiMH batteries and charger plus 2 × CR123A lithium batteries
Weight (no lens)	800 g (28.2 oz)
Dimensions - body	149 × 125 × 80 mm (5.8 × 4.9 × 3.1″)

lenses we have been using for years (Nikon, Tokyo, Japan). We recognized this advantage immediately. Another advantage is the ability of use more than 1 media storage system (CompactFlash and SmartMedia). Those 2 storage systems were, at that time, competing to become the standard media of storage. Having both systems as options made the FinePix S1 camera less likely to become obsolete, and it was also user-friendly. The system (Fig 2) looks very much like the slide camera systems we had been using for years. The cost was competitive with film systems. The only hardware additions to the slide camera system that we had been using for years were the back (Fuji S1) and a special filter for digital photography (52-mm standard hot mirror filter [Tiffen, Hauppauge, NY]).

Aware of availability problems and constant changes in technology, we decided to purchase the systems for the department instead of having the

Table II. Components of digital photography system used in Case orthodontic clinic

Hardware
- Fujifilm FinePix S1 Pro (discontinued, replaced by S2 Pro)
- Nikon Macro Speed Light SB-29 Flash (Nikon, Tokyo, Japan)
- Nikon AF Micro Nikkor 105 mm 1:2.8D Lenses (Nikon)
- 128 MB Kingston Flash Card (Kingston Technology, Fountain Valley, Calif)
- Quest Q2 AA Battery Charger (Harding Energy, Norton Shores, Mich)
- 12 - 1800 mAh NMHI rechargeable AA Batteries (4 for the body, 4 for the flash, and 4 always charging) (Harding Energy)
- 52-mm Standard Hot Mirror Filter (Tiffen, Hauppauge, NY)
- USB Compact Flash Card Reader (SanDisk, Sunnyvale, Calif)
- "Photo Station" Computer (commonly referred to as Image Capture Station): Dell Optiplex GX240 Pentium 4-1.8 GHz; 256 MB RAM; DVD-ROM/CD-RW 40× read speed, 16× write speed, 10× rewrite speed (Dell, Round Rock, Tex)

Software
- Adobe Photoshop (Adobe Systems, San Jose, Calif)
- Dolphin Imaging (Dolphin Imaging and Management Solutions, Chatsworth, Calif)
- ACDSee (ACD Systems International, Saanichton, British Columbia, Canada)
- Vistadent (GAC International, Bohemia, NY)
- Roxio Easy CD Creator (Roxio, Santa Clara, Calif)

File specifications
- 3040 × 2016 Pixels.
- Approximately 1.1 Mb as JPEG in standard mode.

Fig 2. Clinical camera system.

residents buy them every year. Hence, a protocol and a system were created for using and storing digital images (Table II). This system has been working well for the past year and a half, and it could be useful in universities or group practices.

The Department of Orthodontics at Case Western Reserve University currently accepts 4 residents per year. The program is 30 months long; 12 residents work in the clinic for 6 months. The residents are divided into 4 "families."

The department purchased 5 camera systems, 1 for each family of residents, and an extra for backup. Each resident received a 128 MB CompactFlash (Kingston Technology, Fountain Valley, Calif). All residents have their own cards, so they can organize their files at their leisure, thus avoiding mixing files or losing data.

Like a slide, a digital image must be labeled. In digital format, the label is the file name. Our protocol for naming files is "patient's name—intraoral or extraoral type of photo." Example: J. Martin Palomo—extraoral profile. The files are stored in a folder named "treatment stage—date." Example: Initial—May 5, 2003. The information is then recorded to a compact disk (CD).

CDs can be found in 2 different formats: CD-R and CD-RW. CD-RWs are designed for short-term storage and are not ideal for record storage. The CD-R can be manufactured in several ways by using different dyes. The dye used determines the quality of the CD and its life expectancy. A lower-quality CD has a shorter lifespan and shows more errors during recording sessions, because of its weak reflection contrasts. The most-used dyes in order of highest to lowest quality are phthalocyanine (lifespan of more than 200 years when coupled with gold), metallized azo (up to 100 years), and cyanine (up to 50 years). Higher-quality CDs cost a little more and can sometimes be identified by the manufacturer's labels and the color of their recording area. The phthalocyanine dye (often used in Kodak, Ricoh, and Acer CDs) usually has light green or light yellow on a silver or gold reflective surface. The metallized azo dye (usually used in Mitsubishi/Verbatim CDs) is deep blue on a silver reflective surface. The cyanine dye (usually used in Fuji, TDK, Maxell, and Pioneer CDs) can be green-blue (lifespan of about 10 years) or blue (up to 50 years) with a silver reflective surface.[6]

The storage capacity of current CDs is either 750 or 800 megabytes. This is more than enough to store all of a patient's records (pictures, digital radiographs, and templates) even when using high quality images. Therefore, a single CD can hold the initial, progress, and final records of 1 patient. Leaving the CD "open" allows other folders and data to be added later. To be able to go back to the CD and add new data, one should "close" or "finalize" the recording session, but do not close or finalize the CD. Be sure to note the data recording method and the type of CD.

After the data are stored in a CD, it is labeled with the patient's name, date of birth, and the folders it contains with respective dates. Example: a CD can be named "J. Martin Palomo—DOB XX/XX/XX." On the next line, there could be "Initial— 10/05/03" and so on. When the CD is labeled, it is placed in the patient's folder inside a protective sleeve. The CD serves as a digital backup.

The Photo Station computer (Dell, Round Rock, Tex) has folders for each resident, containing folders for patients they treated. All computers at Case's Department of Orthodontics have a daily backup through the network, providing another source of digital backup.

A hard-copy backup is also used by creating and printing a 1-page picture template. The patient's name, date of birth, stage, date of records, and all 8 pictures are shown. The residents create a picture template using Dolphin Imaging (Chatsworth, Calif), Vistadent (GAC, Bohemia, NY), ACDSee (ACD Systems, Saanichton, British Columbia, Canada), or Microsoft Word (Microsoft, Redmond, Wash). The results are similar. This template is recorded to the CD and also printed on a laser printer, which is preferred for economic reasons. This printout is placed in the patient's folder.

Therefore, the images are stored in 3 places—computer, CD, and hard copy; these also work as backups. The protocol is as follows:

- Take pictures.
- Download pictures to Photo Station computer and name files.
- Create a folder with patient's name.
- Inside patient's folder, create another folder with stage and date, and put all images inside this folder.
- Record data to CD and put CD in patient's folder.
- Create picture template, print it, and insert it in patient's folder.

CONCLUSIONS

The Department of Orthodontics at Case Western Reserve University upgraded all clinical photography systems to digital format. A digital system was developed. This system has been used for over a year in a practice with 12 orthodontic residents and can be incorporated in group practices of any specialty.

The technology in digital photography changes rapidly, with new products reaching the market constantly. Therefore, a digital photography system needs to be selected with this in mind.

Potential upgrades to the system presented here can include DVDs as a storage system, especially if digital videos were used for patient records.

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