27. Digital photography

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Strange times these are! Anyone reading this chapter is living through a paradigm shift. A paradigm shift occurs when an excepted method or model, such as film photography, is replaced by a new method or model, in this case digital photography. When a paradigm shift occurs, all the previous rules change and the new technology is often met with skepticism, as it requires people to change their thinking and the way in which they do things. Sometimes people are so ingrained in the previous technology that they are blinded by the benefits of the new technology and miss progress.

The Swiss watch-making industry invented the quartz liquid-crystal timepiece but did not even patent the idea. Their leaders were blinded by this new technology and did not take it seriously; after all, it was a departure from their paradigm. It could not be a timepiece; there were no moving parts, no jewels, and no movement. This watch needed no winding, was 1000 times more accurate and was cheap to manufacture. The Japanese saw this potential and snatched the patent and the rest is history; the Swiss lost dominance in the timepiece industry. The moral here is never underestimate a paradigm shift. Go with the new technology!

The new technology of digital photography is in its Stone Age infancy but it is advanced enough for every contemporary cosmetic surgeon to convert yesterday. Many people are hesitant to make the conversion from film photography to digital photography and they offer many excuses: 'The technology is changing too fast', 'The resolution is not high enough', 'I am computer illiterate', etc. Remember it is natural to fear a paradigm shift.

With all this in mind, it must be remembered that technology cannot be outraced, so a point at which to jump in must be chosen. This point occurred in about 1997. It is now easy, accurate and affordable to use digital photography in medical practice.

DIGITAL CAMERAS

Film photography was popularized in the early 1800s and, with notable refinements, has essentially remained the same. The process involves a lens that focuses on a subject and a shutter that controls the amount of light that is shed on a photosensitive medium. This entire process is a mixture of light and lens. The photosensitive medium is then wet processed into negatives, slides or photographs. Not much has really changed since the Civil War.

Digital photography, although new, also relies on light and lenses. The front half of the digital camera is not much different to a conventional film camera; the main difference lies in the photosensors within the camera. These sensors are called charged coupled devices (CCD) and function by processing focused light into a digital mode – ones and zeros to be specific. The higher the bit of the CCD, the more shades of color will be seen, i.e. a 12-bit CCD chip is superior to an 8-bit CCD. An 8-bit CCD chip will record 16.7 million colors while a 12-bit chip will record 68.7 billion colors, which is true photographic photography. The colors increase exponentially with the increase in bits. Each pixel has a code for various colors and this combination allows the picture to be assembled. Since the number of pixels is proportional to the amount of digital information, the higher the number of pixels, the more information within the photograph. For all practical purposes, this information is called resolution and one can basically say that the higher the number of pixels, the greater the resolution and the better the picture.

There are a myriad of digital cameras available and they change weekly. Like most high tech hardware, the same product will probably not be in use 48 months later. Digital cameras can be classified into three main types: toys, consumer grade and professional. The inexpensive digital cameras with 640×480 resolution were the first-generation cameras. They are still sold for several hundred dollars and are fine for e-mailing pictures to family and friends, but will not suffice for clinical digital photography. Consumer-grade digital cameras run the full gamut of price and accessories. Most cameras that will suffice for clinical digital photography are in the $800–1500 price range. Professional-grade digital cameras are in the $5000–15,000 price range and are usually out of the reach of most cosmetic surgeons. Just because a camera is expensive does not mean that it is ideal for clinical photography. However, it is important that a good consumer-grade digital camera should perform as well as the professional counterparts, and it can if the basic important functions are present. There are several critical requirements for clinical digital photography, which will now be discussed.

Resolution

Resolution is one of the major misunderstandings in digital photography. Many people feel that resolution is the only important factor in digital photography, and mistakenly assume that the higher the resolution, the clearer the picture. While this statement holds some truth, resolution actually relates to the size of an image. An image captured at 640×480 pixels will print out at about the size of 7×9 inches (16×22 cm). This is the same resolution as an National Television Standard Committee (NTSC) video signal or the same size as that played on a VCR. An image about twice the size (1024×1280 pixels) will print out at about 14×18 inches (36×45 cm). The gold standard for resolution is still 35-mm slide film, the resolution of which is approximately 3000×4000, which would theoretically equal 12 million pixels. The maximum resolution of consumer-grade digital cameras at the time of publication is 3.3 million pixels. With this in mind, half of the resolution barrier has been conquered in about a decade. Certainly, the next decade will breach the gold standard and develop extreme resolutions. Figure 27.1 illustrates the relative size in digital resolution as compared to 35-mm slide film.

As resolution has increased, so has the demand for memory. Higher resolution images may be 10–80 megabytes (MB) and storage solutions are much needed. In the early 1990s a laptop computer with a 170MB hard drive was a cutting-edge machine. At the time of publication laptops are available with 30 gigabyte (GB) hard drives. There is no doubt that image resolution and storage capacity will increase concomitantly. This raises the question of how much resolution is required for medical photography. A resolution of 1280×1024 pixels is adequate for accurate detail. This minimum standard will constantly increase in concert with digital camera resolution and soon minimal resolution will be an obsolete phrase.

The author currently uses a resolution of 1280×1024 pixels, which is a mid-range resolution provided by most high-end consumer digital cameras. This resolution works well in terms of detail, does not overpower the Windows operating system and is suitable for most academic applications, including clinical archiving, multimedia lecturing, and scientific publications.

Through the lens focusing

Through the lens focusing (TTL) is another important requirement. Most practitioners are used to taking clinical images with 35-mm single-lens reflex (SLR) cameras. These cameras have focusing systems that allow the user to view the same image that will be registered on the film, i.e. it is essentially a WYSIWYG (what you see is what you get) system. Rangefinder types of cameras are not TTL and there is a phenomenon known as parallax in which the same image

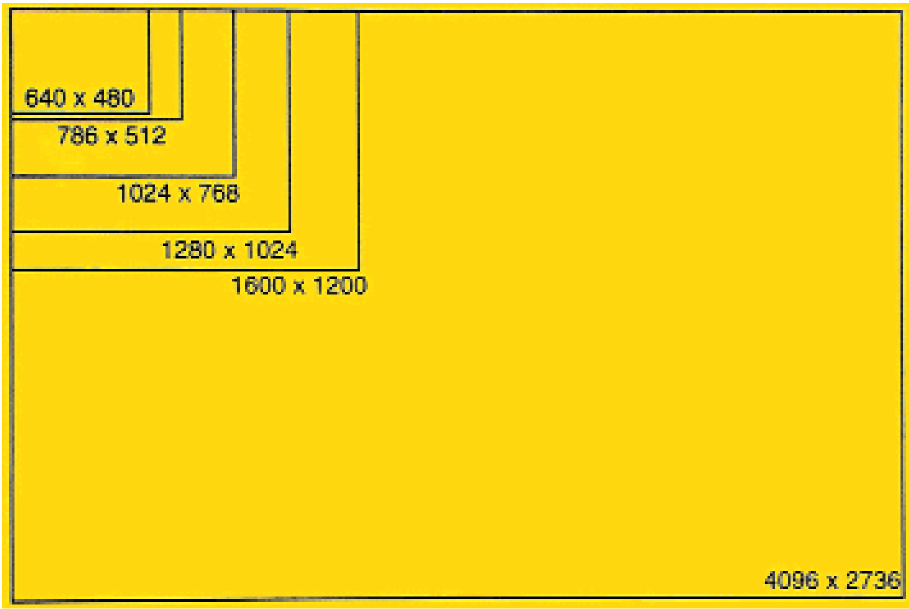

Figure 27.1 *The number of pixels captured with digital camera (i.e. resolution) compared to the resolution available with 35-mm slide film.*

viewed through the rangefinder lens is not the exact image registered on the film. This can be very frustrating, especially with macrophotography, as the image seen may not be the same as the picture produced, e.g. the edge may be cut off or it may be off center.

Flash location

Flash position is another important feature. As with any camera, the flash will frequently make or break an image. Since most cosmetic surgeons require close-up images, a digital camera should be versatile in that respect. Cameras with flashes that are mounted far from the focusing lens can be problematic because the closer the camera is held to the subject, the further away the flash will be. In a real situation, a flash mounted 5 inches from the lens is fine for a full-face or full-body image, as the flash will be far enough away from the subject to disperse and shower the entire area with light. If the same camera is used to focus on the ear at a distance of 2 inches, the flash will be positioned 5 inches away and light up the nose but not the ear (Figure 27.2). With this in mind, the closer the flash is to the lens, the better the arrangement for macrophotography. Obviously, macroflashes can solve this problem but, in the author's experience, the proper digital camera can take 99% of clinical images without specialized flashes or lenses.

Figure 27.2 *The problem of a flash attachment being mounted too far away from the lens is illustrated; the closer the flash is to the lens, the better suited the camera is to macrophotography.*

Macrolenses

Macrolens capability is paramount for a suitable clinical camera. Inexpensive cameras may advertise 'macro' capability but produce distorted images. With lenses, you get what you pay for and the higher end cameras usually have superior lenses, e.g. the Olympus C2500L can focus to 0.8 inches. A good

Figure 27.3 *PCMCIA cards are excellent storage devices for digital images and can easily be attached to all current notebook computers and to desktop computers with an appropriate slot.*

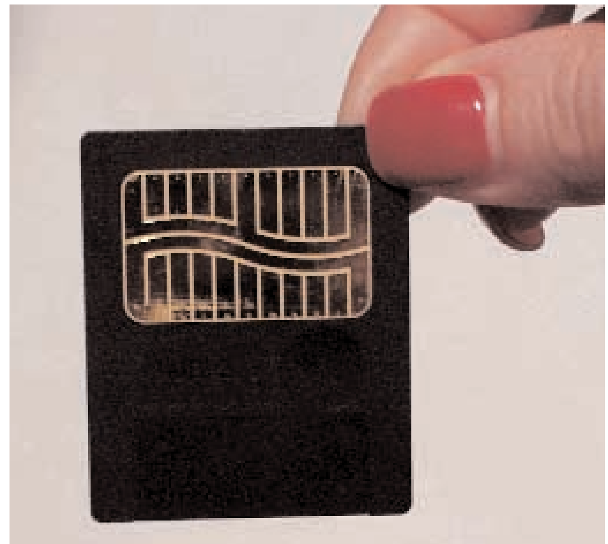

Figure 27.4 *The SmartMedia storage card is a wafer-thin storage medium that has become increasingly popular in various digital cameras.*

means of evaluating the quality of a macrolens system is to take a picture of text from a book; if the periphery of the image is significantly distorted then the macroimages will be too. Many digital cameras offer diopter lens kits that allow the user to screw on macrolenses of various magnifications. The biggest problem with taking good macroimages is the camera flash, as mentioned previously.

Liquid-crystal display

A liquid-crystal display (LCD) monitor is an absolute necessity for a clinical digital camera. The main advantage of digital photography is the ability to immediately preview an image. One of the greatest disappointments with 35-mm photography was photographing that rare clinical lesion to find out a week later that the image was out of focus or that the processor destroyed the film. Without an LCD monitor on the digital camera, it is not possible to know whether the image just taken is adequate or not. With digital photography there is no reason to ever take a bad picture, because it can be previewed and a better image retaken if necessary. That ability is lost without a monitor and this will result in disappointment when images are downloaded to find out that the out-of-town patient blinked and had their eyes closed in the picture that is needed today. *Do not* purchase a digital camera without an LCD display.

Removable memory

Image storage is also another important thing to consider. *Do not* purchase a digital camera that does not have some type of removable storage medium. There are various storage media available. Personal Computer Memory Card International Association (PCMCIA) cards are credit-card sized memory cards that will work on all laptops or desktops with a special card reader (Figure 27.3). They function well and, depending upon the configuration, can be purchased with 8MB to hundreds of megabytes of memory. These were popular on the earlier digital cameras but are quickly being replaced by more compact media. SmartMedia cards are wafer-thin memory cards about the size of a matchbook cover and are currently very popular. In addition, some cameras have CF (CompactFlash) memory slots for future technologies, or to use as a secondary CF memory slot – CF memory cards are about half the size of PCMCIA cards. The author has

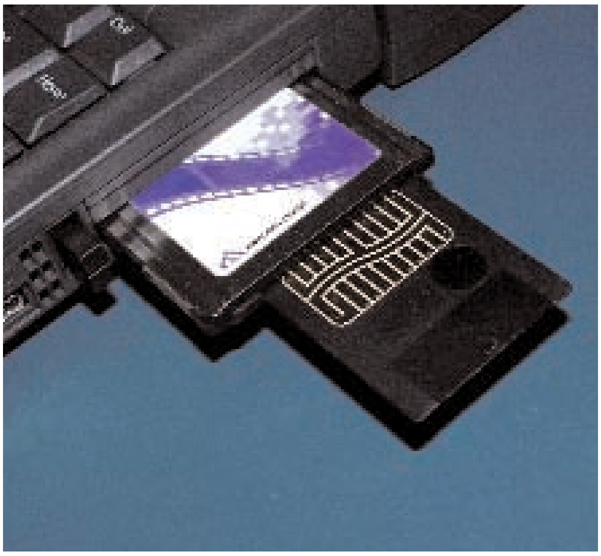

Figure 27.5 *PCMCIA card-readers are available for the SmartMedia storage cards. The SmartMedia card simply inserts into the PCMCIA card which, in turn, inserts into the computer.*

Figure 27.6 *USB card-readers are a great and portable alternative for reading SmartMedia cards and other types of digital camera storage cards. Most new computers have USB ports which enable the use of this type of card-reader.*

experimented with all major digital camera systems and prefers a SmartMedia type of storage system, which is used by Olympus and other manufacturers (Figure 27.4). This wafer-thin storage medium is placed into the camera and used to store the images. The amount of memory currently ranges from 8 to 128MB. Depending upon the selected resolution of the camera, anything from several to several hundred images may be stored in a single media card. The media card is then removed from the camera and placed in some type of reading apparatus. Various types of card-readers are available. A specialized 3.5-inch floppy disk card-reader is very popular, as most end-users are comfortable with this interface; they are easy to use and are relatively expedient at image transfer. Since floppy drives are not terribly fast, it may take up to 1 minute to transfer images; however, it is a tremendous advantage over cable transfer. Most digital cameras have cables that connect most frequently to a serial port for image transfer. Although this is inexpensive, it is very slow and takes several minutes per image, making it a waste of time, and time is money. Newer cameras may incorporate a universal serial bus (USB) adapter, which enables extremely rapid image transfer. Still, one must deal with cables and adapters.

The PCMCIA interface is familiar to all laptop users, as modern laptops usually have two PCMCIA slots. PCMCIA card-readers are credit-card sized devices that accept the SmartMedia card and plug into the PCMCIA slot on laptops, or into PCMCIA card-readers for desktop units (Figure 27.5). The PCMCIA interface is rapid and the images are read as an additional drive on the computer; image transfer is virtually instantaneous with this interface. One problem that the author has encountered is that each card has a separate driver. Most cards will be recognized by Windows Plug-and-Play applications and will function with a default Windows PCMCIA driver. However, in the author's experience, if one uses multiple cards from multiple companies, serious driver conflicts may result that can be very difficult to resolve. The author has been forced to initialize his hard drive several times due to PCMCIA driver conflicts. Whilst still using them, the author tries to use only a single card and if an additional card is used for another camera then it is one from the same manufacturer; this has worked well so far.

The newest type of card-reading device is the external USB card reader (Figure 27.6). These powerful devices are inexpensive and can fit in the palm of the hand. They plug into the USB port on laptop or desktop computers. USB readers are available that read PCMCIA, smart card and SmartMedia formats.

Function control

Automatic and manual camera modes are also important with clinical photography. While most clinicians are interested in fully automatic functions, there may be times where lighting requirements warrant manual modes. The author has found this to be true especially when photographing in the operating or emergency room. Even using the camera in different office treatment rooms with varied lighting can make a difference. In order to standardize the images, sometimes it may be necessary to adjust the flash, shutter speed and the analog of International Organization for Standardization (ISO) settings, exposure and white balance. The more automatic features that are available, the better, because there is nothing easier to use than a 'point-and-shoot' camera.

Accessories

Accessory adaptation may be an important feature for many clinicians. If one desires to use macro flashes, slave or background flashes or conventional 'hot-shoe' flashes then having a flash port or a hot-shoe adapter is important. These allow synchronization with the shutter, as do professional cameras. Other adaptations include a direct current (DC) input, which will allow the use of house current instead of batteries. Most digital cameras have data-transfer ports. One useful connection is a video-out port that allows the user to project the images directly onto a television screen. This can be useful in consultations or in an environment when a computer is unavailable. The author highly recommends purchasing two sets of nickel–cadmium (Ni–Cd) rechargeable batteries so that fresh power is always available. Digital cameras are very draining on conventional batteries; a camera can be used for an entire week on a Ni–Cd charge.

COMPUTERS FOR IMAGING

Laptop computers have already been mentioned several times thus far and the point should now be made that the author recommends laptops for medical imaging for many reasons. The author takes about 4000 images each year and in earlier times had these images only on the office desktop computer. It seemed that so many times images were needed at home or on the road. The author then began copying images and transferring them to the home computer, and it did not take long to confuse which images were duplicates and which images were on which computer. Worse than that, there was no convenient access to images whilst traveling.

As laptop memory and processor speed increased, one was used solely for imaging. This was an emancipating event for progress. All images could be stored on one machine, which could be taken home, to various satellite offices, to the hospital and, most importantly, on trips. Digital imaging is more than a function, it is a hobby! For those who rely upon images for clinical and academic reasons, one must continually download, process and archive these images. Although it takes some time every night, or several times per week, it pays off exponentially when the images are required to work for you. State-of-the-art imaging software will automate much of this work but none the less one must stay abreast of archiving. As the old adage goes, 'garbage in, garbage out'.

When discussing the ability of a digital media camera card to store images, more is good but not always better. Some of the media cards can hold hundreds of pictures and it is definitely human nature for us to not download our images until we have to. In view of this, if the media card malfunctions (and you know it will at some point), you will lose all of the images that have not been downloaded. Also, a big problem with allowing images to pile up is that by the time you finally download them, archiving becomes a big problem. You are now staring at perhaps 100 images and it is usually impossible to remember whose eyelid it is or how many days after surgery another image was taken. As already stated, most esthetic surgeons are very serious about their images and good doctors will spend regular time attending to them.

It is human nature to try and use what we have, but skimping on an imaging computer is bad business. Computers are like cars, motorcycles, boats and airplanes in that you will be sorry later for not purchasing enough power. As image resolution

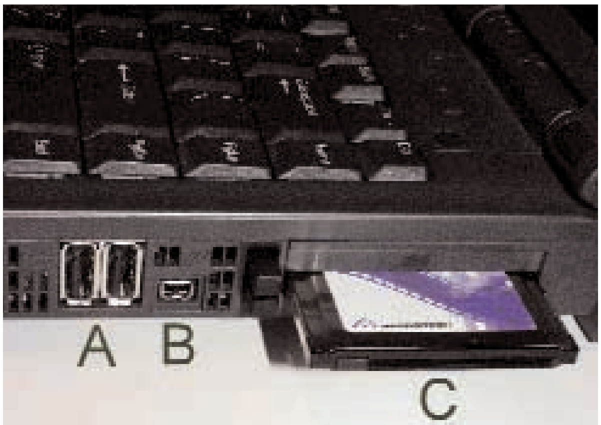

Figure 27.7 *The versatility of today's portable computers is illustrated: (A) USB ports; (B) a 'firewire' port; (C) a dual PCMCIA slot.*

Figure 27.8 *A removable CD recorder with a notebook computer is the author's choice for mobile data backup.*

continues to increase, computer processor speed, RAM memory and hard drive size have increased as well. At the time of this publication, the author recommends a notebook computer with a 700-MHz processor, 256MB of RAM, a 30GB hard drive and a 15-inch LCD screen. A computer of this stature will retail for between $3000 and $4000. Other important options to look for when buying a computer for imaging (whether notebook or desktop) are the presence of USB ports, composite and Super Video (S-video) inputs and outputs, and an Institute of Electrical and Electronic Engineers (IEEE) 1394 (firewire) port (Figure 27.7). These interface ports will allow for uploading and downloading not only digital camera images but digital video, which is the next vista in clinical photography. Many brand name computers have these interface options built into the computer, while others accomplish this hook-up through docking stations or port replicators.

BACKUP STRATEGIES

For any clinician who has amassed a large collection of Kodak slides, it would be devastating to lose this entire collection, as it takes many years to accumulate and organize. Short of a house fire, it would be difficult to lose one's collection, but none the less devastating. It must constantly be kept in mind that an entire digital slide collection could be lost in a matter of seconds from a computer virus or malfunction. The 'Love Bug' virus that swept the world in May 2000 is a good example. This virus was attached to an e-mail and, when activated, searched one's entire hard drive for JPEG images and corrupted them. The author personally lost several thousand images, but had luckily backed them up the previous week. However, the images that were not backed up were lost and some of these images were from the operating room and of unique pathology, and can probably never be replaced. Unfortunately, there were thousands of computer users without any backup strategy who lost everything. If this has never happened to you, I can guarantee that it is a feeling of extreme violation. Don't be stupid; backup your images! The best strategy is to backup on a regular basis. The author tries to do this before going to bed at night so that next morning the job is complete.

There are multiple means to back up image data, varying from floppy disk to much larger storage media. The author prefers a laptop computer with a CD-recordable removable drive, as 700MB of data can be backed up on a single disk and it is an extremely stable medium. The portability is also paramount as one can backup on the road (Figure 27.8). The author has about 5000 images on his computer and it currently requires two CD-recordable drives to back up these files. Digital versatile disk

(DVD) recordable units are commercially available but are, at the time of publication, very pricey. As this technology improves and becomes more affordable it will become mainstream in the end-user arena. A single DVD can store 7GB of data.

Zip drives are also very popular for backing up data; they are cheaper than CD recordable medium but slower. One advantage is their diminutive size, which allows for great portability.

Another acceptable backup strategy is computer-to-computer data transfer. PC Anywhere™ is a brand name software application that allows the user to access remote computers from any location with a telephone modem service. One can activate PC Anywhere™ from the office computer to the home computer and so can begin downloading images when leaving work; the images will be backed up automatically on the home computer. The problem with this type of transfer is usually speed, as modem transfer is slow. As cable modems and ISDN services become more popular this option will be more appealing. Another advantage of PC Anywhere™ or similar software is that it allows data to be accessed from a remote location. The author was once giving a lecture in Phoenix, AZ, and the night before the lecture realized that one of the presentations about face peels had been forgotten. This was a big lecture and the author was very upset. Luckily, PC Anywhere™ was installed on the notebook computer and allowed connection from the hotel to the office (in Richmond VA), and the forgotten lecture material could be uploaded. It was that day that the author realized the true power of digital imaging. The newer Windows operating system will have remote access capability as a function.

Again, whatever the interface, plan to backup often, as it is guaranteed that at some time one will be faced with data loss or corruption.

IMAGING SOFTWARE

The entire advantage of digital photography is having the ability to instantly process an image and have total control over the editing of that image. Imaging software has become very sophisticated during the past decade. Imaging software has gone from \$20,000–30,000 systems to systems that are < \$1000 today. In examining imaging systems it is important to compare like with like. Some very high-priced systems cannot outperform lower priced systems and some low-priced systems have very limited imaging functions. It is important to know what to look for when purchasing imaging software. Some of the most important features are considered below.

Archiving software

The primary function of any imaging software is to make it quick and easy to download images from a digital camera. This should be through a fast interface such as a USB port or a PCMCIA card; slower interfaces such as serial cables should be avoided. The archiving software should allow the images to be read instantaneously as a separate computer drive. Archiving software should also allow real-time image transfer between folders on the hard drive – an image is of no use if it cannot be found. Good archiving software should allow all image files to be viewed as thumbnail images, so that it is known what the image is and where it is. More sophisticated archiving software systems will also allow basic image editing directly through the archiving software. Simple image manipulation such as rotation, brightness and contrast, and cropping, may be performed directly through the archiving application. The archiving software should allow image properties such as extension format, size, and date taken, to be viewed. Advanced archiving software also allows for 'drag-and-drop' transfer of images between applications. This allows the user to simply move an image from any folder and drop it into a word-processing document or a PowerPoint presentation.

Image editing software

The true workhorse of any imaging system is the image editing capability. Powerful image editors allow professional image manipulation in a user-friendly interface. The image editor is used to perform a multitude of important imaging functions such as image resizing, duplication, cropping, cutting, copying, pasting, enhancing brightness and contrast, hue and saturation, color balance, adding text and arrows, making before and after pictures, adding special effects, retouching and image print management.

Morphing

Morphing is the ability to change a digital image to simulate a given surgical result. Morphing is commonly used to illustrate augmentation, reduction, rhytid and scar effacement, suspension and lifting techniques, anatomical rotation, and other predictive illustrations (Figure 27.9). Image morphing is very interesting as many patients may wish to have some idea of what to expect from a surgical procedure, although it can be a double-edged sword, as a patient may be very disturbed if their surgical result is not as was graphically predicted. A good general rule is to 'not let your mouse write a check that your scalpel can't cash'! All patients should be advised in writing that these 'computer cartoons' are merely estimations and that no result is implied. The author is familiar with at least one case of litigation involving an implied result of predictive morphing. Morphing software varies and some companies offer very complex morphing. It is the author's experience, after being heavily involved in the imaging industry for a decade, that many doctors buy imaging systems for the 'bells and whistles', including morphing. They initially morph everything on everybody but this novelty soon wears off. If the remainder of the system is weak then they are left dissatisfied. The moral is not to purchase an imaging system for the 'bells and whistles' but to look at the total package. In addition, some morphing applications are, in the author's opinion, unnecessary. Some companies offer morphing software to illustrate post-laser erythema by overlying the face with red tones, but it would be more realistic simply to show the prospective patient actual post-laser pictures of laser patients. The author has a computer slide show that shows the post-laser erythema from 24 hours to 30 days postoperatively. The author also shies away from complex and frequent morphing for most surgical procedures and instead shows the patient digital slide shows of actual before and after surgery that he has performed. This not only gives a realistic idea of what can be accomplished but also shows the author's proficiency as a surgeon. The author feels that there is a place for clinical morphing, but it is not as popular as it was a decade ago and it is no longer a novelty or a sign of advanced technology, as it is available for free as shareware and on children's software.

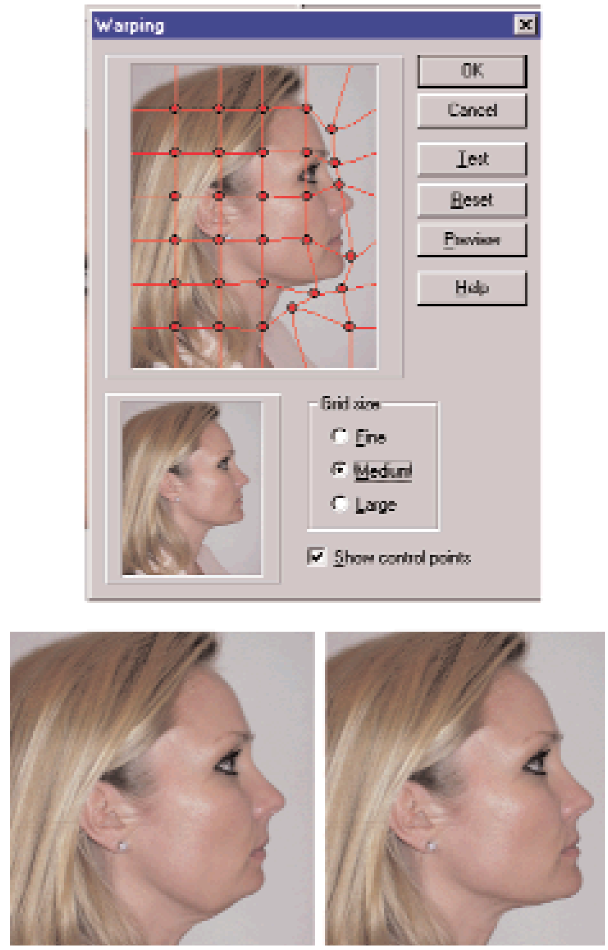

Figure 27.9 *An example of image morphing, which has become very popular for demonstrating presurgical computerized predictions of outcome.*

Presentation software

Merely having images does little; making images work does more. With the sophistication of quality imaging software, it is easy to make digital presentations, slide shows, patient education programs, and before and after pictures, add images to referral letters and pamphlets, and perform a multitude of desktop publishing applications. Computer digital presentations using Microsoft PowerPoint™ and other programs are becoming the standard for most professions. The advantages over carrousel slide presentations are obvious. Some imaging systems offer standalone presentation programs that allow the user to make sophisticated multimedia presentations simply by clicking on the images they wish to include. In the author's practice, digital-image presentation shows for the major procedures performed have been made. If a patient presents for a laser resurfacing consultation, they are taken to the consultation room, handed a mouse and can then proceed through a multimedia presentation at their own pace. This presentation shows the causes of the pathology, the actual procedure (with a full-motion video), the postoperative appearance and care, the various phases of healing, multiple pre- and postoperative cases, and a discussion of complications. When the consultant re-enters the room, say 10 minutes later, the patient has a good idea of what resurfacing consists of and the personal consultation time is decreased. More importantly, the patient has a much clearer idea of what to expect and what not to expect. This is some of the most important time spent with the patient. If the patient desires, they are presented with a CD of the presentation to show their friends or spouse. In the reception room a continuously looping digital presentation of the causes of facial aging and the various cosmetic procedures available is played.

Databasing software

The more advanced imaging systems offer front- and back-end databases that enable the user to add fields to each image, and then have the ability to search for these fields. For instance, a doctor may have an image and attach fields for the patient name, referring doctor, insurance company, procedure, date, complication, place of service, etc. If the surgeon wants to perform a search for all patients treated over a given period who were, for example, Asian females with breast augmentation who experienced capsular contraction with a specific implant, this can be done with several mouse clicks. The problem with databases is that one must enter all the data for each image, which is very time consuming. This is beyond the desires of most clinicians, but those involved in research or specific projects will appreciate this ability.

There are a multitude of other functions that are offered by imaging companies but the aforementioned applications are the most important ones.

MAKING DIGITAL IMAGES

Many problems that existed with conventional film and slide photography have been eliminated with digital photography. The frustration of taking pictures and getting them back from the processor a week later and having important images out of focus, patients with their eyes closed or improperly exposed images was known to all clinicians. There is no need to take a poor image with today's digital camera. The ability to preview all images will allow the doctor to simply retake an improper image.

Standardization is by far the most important single factor in making clinical images. Standardization has been greatly improved by digital technology, in that one can post-process images to adjust for some parameters that were not standardized at the time the image was taken.

Image standardization should be the main goal of every clinician, as it is much simpler to take controlled images rather than to spend time editing each image. The following represents some of the more important factors in image standardization.

Background

Background is perhaps the most important variable when taking consistent images. It is unfortunate that some doctors do not pay attention to backgrounds, producing images showing office equipment or doors as the unfocused background. The author uses a white flat-finish, non-reflective wall as a photographic background. White is preferred because if printing out images a color or black background wastes ink or toner. Shadow control is the biggest problem with light colored backgrounds, which can be corrected by various means. Slave or background bounce flashes are techniques utilized by professional photographers. Simply rotating the digital camera to the vertical position can control the angle at which the flash approaches the image. The author rotates the camera vertically when taking profile images so that the flash presents in a direction so as not to cast a shadow from the nose and chin (Figure 27.10). If the author is photographing a right profile, the camera is held vertically to the right so the flash is directed towards the patient's anterior profile. Another trick that may prove handy is not to use any flash. The more expen-

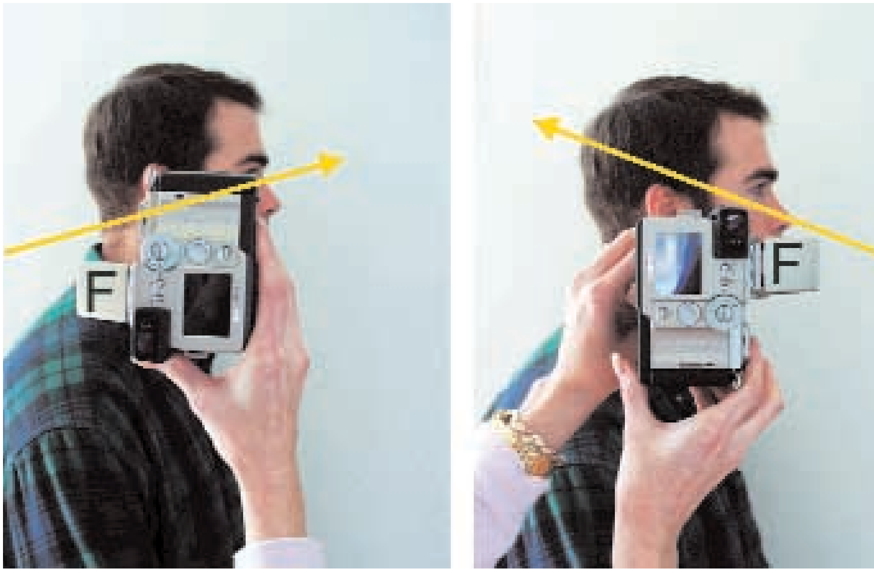

Figure 27.10 *Although ring-, point-, slave- and background-synchronized flashes are available, simply positioning the camera to control the flash angle can eliminate shadows. When taking a profile image, having the flash horizontal, or coming in from the back of the head (left frame), will cause a shadow; simply rotating the camera, so that the flash comes in towards the patient's profile, will prevent shadowing.*

sive digital cameras have excellent exposure capabilities and, providing the room lighting is sufficient, may not need any flash to expose the image. In the case of no flash, there is no shadow.

Focal distance

The distance from the camera to the subject should be the same for all images. This can be controlled by marking a place on the floor for the photographer to stand. Another means is to attach a piece of string to the end of the camera and always hold that string the same distance from the subject.

Ambient lighting

Ambient room lighting can severely influence the quality of any photograph. There are significant color differences between incandescent and fluorescent lighting and compensations must be made. The reflections from surrounding walls, furnishings and clothing may also influence the color and quality of the image. Although an advantage of digital photography is portability, it is convenient to do most photography in one room that has been set up for color and light standardization. Most high-quality digital cameras offer a vast array of exposure and ISO settings that can compensate for photographic variables. The trick is to experiment until an acceptable control is achieved, and then maintain that variable control for all images. When attending meetings, many participants judge the competency of a presenter by the quality of his or her images.

WHAT DOES THE FUTURE HOLD?

Digital photography, although still in its infancy, has progressed exponentially in less than a decade from a novelty to the touchstone of clinical record keeping. This technology will continue to improve and one of the drawbacks about keeping up is the rapid obsolescence of current technology. The good news is that the computer will enhance our professional lives, including photographic records.

A big question in everyone's mind is how will digital images be standardized? In order for them to stand as medical records, an unalterable and secure format is required. Attempts to find an image-protection standard have begun, as many see the necessity for unalterable images. Also important is a universal standard for all machines and devices to be able to recognize shared data. Digital imaging and communications in medicine (DICOM) is a format being phased in at medical centers and hospitals, and its eventual penetration into all health-care services is

Figure 27.11 *Affordable digital camcorders and new technologies enable the use of full-motion video in clinical and academic applications.*

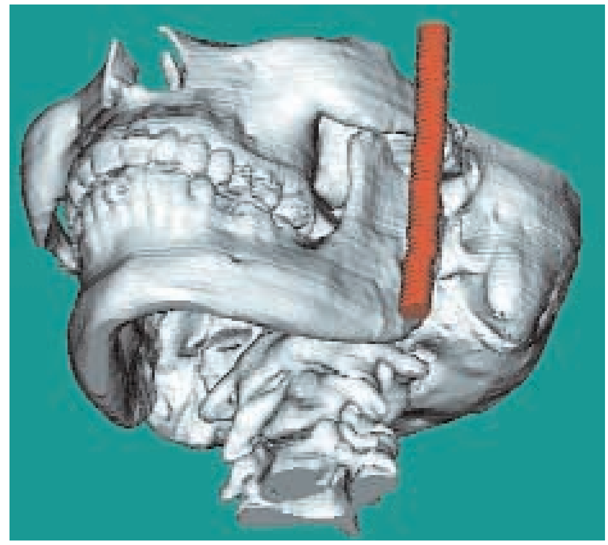

Figure 27.12 *A spiral or 3D computerized tomography scan of the skull. This technology has existed for over a decade and is valuable for diagnostic purposes as well as CAD–CAM implant construction.*

likely. The DICOM standard is being developed so that one vendor's product can communicate with another vendor's devices. The DICOM system also uses a modular tagged-file format, which allows the storage of vital medico-legal and diagnostic information relating to that specific image. This information is referred to as unique identifier (UID). The information can include a record of the patient visit, the patient's vital statistics, detailed information on how the image was made, what device was used to make the image, the patient's personal information and reams of other information.

Full-motion video is more powerful than still images because it allows procedures to be illustrated in real time, with narration. Digital camcorders are now available with the qualities and capabilities to transfer full-motion video to computer presentations. The main limitation is the intensive memory required. As more powerful compression schemes continue to develop, academic medicine will be enhanced by the ability to add full-motion video to presentations (Figure 27.11).

Three-dimensional applications are being developed, which allow the clinician to view the patient in this mode, with the ability to rotate the virtual patient in space. Although this technology has existed in radiology in terms of scan reconstruction (Figure 27.12), the ability to perform this with photographic methods is in its infancy. At present this requires expensive and cumbersome hardware, but will soon become the standard and two-dimensional images will probably fade away with BetaMax VCR and eight-track tapes.

The Minolta Corporation (www.minolta.com) currently has the only portable three-dimensional digitizer; the Vivid 700 digitizer is about the size of a small portable TV. This device uses a projected laser stripe to scan an object. The object may be placed on a rotating turntable to be scanned over all surfaces. When this is done, the object can be rotated in all planes on the computer for viewing. GTI Technologies (www.genextech.com) markets a portable three-dimensional clinical camera apparatus. The x,y,z-coordinates for all visible points on the surface object can be provided by a single three-dimensional image (Figure 27.13).

When scanning a face, for example, the laser beam scans all of the facial contours and the computer software triangulates the position of the anatomy relative to the viewpoint of the observer. It then allows the user to view the three-dimensional image on a computer with the ability to rotate the

Figure 27.13 *Although in its infancy, three-dimensional photography is evolving as a readily available clinical tool. The next decade will surely refine the ability to view images in all dimensions.*

face through texture grids. This exciting technology will become more advanced and popular in the years to come.

The internet has affected our personal and professional lives. Telemedicine is also rapidly developing and will enable the remote diagnosis and treatment of patients, with the ability to transfer data around the world in seconds. Virtual surgery, where a surgeon at one location performs robotic surgery at a remote location, is no longer in the realm of science fiction – serious research is occurring in this arena.

Further reading

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