Digital Photography of Digital Imaging and Communications in Medicine-3 Images From Computers in the Radiologist's Office

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To fully take advantage of the widespread use of digital imaging systems and to update and eliminate redundant steps involved in medical radiographic publication, we present our experience of processing Digital Imaging and Communications in Medicine (DICOM)-3 digital images from the point of acquisition to the point of publisher-ready radiographic images without intervening hardcopies.

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THERE ARE AN INCREASING number of radiographic modalities using digital images. With increasing reliance on digital imaging, many of the conventional steps in producing image-intensive radiologic publications can be bypassed for both the academic radiologist and the publisher, resulting in savings of time, effort, and money.^{1,2} Teaching files can be created faster and stored more efficiently in the digital format.³ We describe our experience with direct image capture of Digital Imaging and Communications in Medicine (DICOM)-3 images using desktop computers without intervening conventional hard copies.

METHODS

Once the computed tomography (CT) and magnetic resonance imaging (MRI) studies have been acquired, the 16-bit DICOM images are automatically transferred to one of our mini-picture archiving and communications system (PACS) servers (Fig 1 and Table 1). Via the world wide web, authorized personnel, including the medical imaging photographer, can download these images from the servers.

The radiologist can transfer the 16-bit DICOM images of interest to their personal computers (PCs) for further manipulation, such as making appropriate gray scale adjustment by changing the window width and window height. For this task we have chosen the shareware viewer Osiris (University of Geneva, <http://expasy.hcuge.ch/UIN>).

Once the radiologist is satisfied with the images, Digital

Jacket-Osiris will save them in the 8-bit tagged image file (TIF) or Papyrus format, while the MagicView Mini-PACS viewer can save in the 8-bit TIF or Joint Photographic Experts Group (JPEG) format. Medweb mini-PACS viewer allows for easy conversion of the DICOM images to the JPEG format.

Graphic software such as PhotoShop (Adobe Systems Inc, San Jose, CA), PrintShop (The Learning Company Technical Support, Knoxville, TN), and Paint Shop Pro (Jasc Software, Eden Prairie, MN) are used to adjust the images to the desired appearance by adjusting contrast, brightness, sharpness, dot density, and size. Additionally, selected portions of the images can be excluded by cropping the area of interest. If needed, text can be added to the images using the text generator feature on the PhotoShop 5.0.

The image files are then transferred to a medical photographer's Macintosh (Apple Computer Inc, Cupertino, CA) hard drive. Additional modification of the images using the graphic software Adobe PhotoShop 5.0 on a Macintosh computer is also performed by the medical photographers when necessary.

Once the images are satisfactory, they are either saved onto diskettes or printed onto photographic grade paper using a 400-dpi photographic quality digital image printer (PG-3000; Fuji Medical Systems USA, Stamford, CT).

RESULTS

DICOM images are easily converted to other more versatile formats such as TIF, JPEG, and graphic interchange format (GIF). These formats are viewed and adjusted by a number of commercial graphics software, including PhotoShop, PrintShop, and Paint Shop Pro.

The images are printed on photographic paper using the PG 3000 digital printer via the Macintosh. The photographs are generally used for papers submitted for publication and for posters at several scientific meetings. Alternatively, the desired images can be kept in digital format; the diskette can be mailed to the publisher without having to convert to hard-copy photographs. Digital images were used for several electronic exhibits and were sent to the publishers of *RSNA Electronic Journal* (<http://ej.rsna.org>) through the internet.

DISCUSSION

We found that the Macintosh is a superior system for graphics communication. The images are truer to the original radiographs. There are more features with the graphic software available for the Macin-

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Fig 1. Flow chart of the steps taken to process DICOM-3 digital images from the point of acquisition to the point of publisher-ready radiographic images without intervening hard copies.

tosh than with the PC. Most importantly, it simplifies the process of converting digital images to hard-copy photographs via the PG-3000 digital printer.

Macintosh has a “through-put feature” with the photo-printer. The same commands we give to adjust the images are automatically and exactly reflected onto the photo-printer. In other words, what you see on the monitor is what you get out of the printer (WYSIWYG). The PC, however, allows for a better compatibility with the server than the Macintosh. Downloading images with a PC is less problematic than using a Macintosh. We found the PC to be a worthy investment as an intermediary.

Equipment expenditures are not included in the cost comparison between the conventional and digital techniques. Using the PG-3000 digital printer, the average cost for each 5 × 7 inch print is \$2.00. However, the conventional cost varies from \$1.75 to \$3.00 for each 5 × 7 inch print; the cost varies depending on the size of the negative used.

Labor cost is more difficult to compare. In the best circumstances where the downloaded digital images do not require adjustments, the labor required is a fraction of the conventional method. However, if the images required an adjustment, labor cost may be comparable.

CONCLUSION

Downloading digital images to the medical imaging photographer for publishing is promising. With

the utilization of DICOM standard and the ability to transfer images from the scanner to the mini-PACS server, this process is simplified.^{1,4-6} The cost per print is similar when comparing the two methods. However, the need to photograph, develop, and print the selected hard-copy radiographic images is eliminated using the method described here. With the digital method, the images are perfected on the monitor before sending them to the printer, thus eliminating the need for multiple printing. Additionally, the time and cost that are needed to obtain duplication of radiographs are eliminated with the digital method described. With practice and experience, adjusting image parameters will be faster and more efficient. In comparison to the conventional method, the digital process is more efficient in both material cost and labor cost. Therefore, we recommend this system to our radiologists for their publications.

Table 1. Equipment for Digital Photography

Scanning Hardware
CT Scanner: High Speed Advantage CTi (General Electric Medical Systems, Milwaukee, WI)
MR Scanner: Signa Horizon LX (General Electric Medical Systems, Milwaukee, WI)
Mini-PACS and Server Hardware
Dell Pentium II 220-400MHz PCs, 8-16 GB HD, 128-256 MB RAM, 17-19 inch monitors.
Mini-PACS and Server Software:
Windows 95/98/NT (Microsoft Corp, Redmond, WA), Linux/UNIX operating systems
Digital Jacket (DesAcc, Inc, Chicago, IL)-Osiris (University of Geneva, http://expasy.hcuge.ch/UIN)
Magic View 300 (Siemens Medical Systems, Inc, Iselin, NJ)
Medweb DICOM server and viewer (Medweb, San Francisco, CA)
Graphic software (PhotoShop, PrintShop, Paint Shop Pro, etc)
Photography Hardware
Dell (Dell Computer Co, Round Rock, TX) Pentium II 220MHz PCs, 8 to 16 GB HD, 128 to 256 MB RAM, 17- to 19-inch monitors
Macintosh 9500 with 250 MHz processor, G3 accelerator card, 200 MB RAM, Targa Video Board (Truevision Inc, Santa Clara, CA), and a 17-inch Apple Multiscan monitor
Macintosh 9600 with a 300 MHz processor, 200 MB RAM and a 17-inch Viewsonic Multiscan monitor
PG-3000 photograph digital printer with 30 MB RAM built in
Photography Software
Windows 95/98/NT, Macintosh OS8 operating systems
PhotoShop

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