Digital vs 35-mm Photography

To Convert or Not to Convert?

Mimi S. Kokoska, MD; John W. Currens, MD; Chris S. Hollenbeak, MA; J. Regan Thomas, MD; Brendan C. Stack, Jr, MD

Objectives: To compare the quality of images generated from a conventional 35-mm camera with those generated from various digital cameras; and to note the costs of the cameras and ease of use.

Design: A prospective, randomized, independent analysis of specific facial images taken with a 35-mm camera and 3 digital cameras by 3 facial plastic surgeons who were blinded to camera type.

Setting: An academic medical center.

Subjects: Thirteen volunteer subjects ranging from age 27 to 58 years.

Main Outcome Measures: The overall quality, focus, distortion, trueness of color, resolution, contrast, and presence of shadows were evaluated for each image. Attributes were scored on an ordinal scale of 1 to 5. A 1-way analysis of variance was used to test whether the average scores across cameras were significantly different. Results using analysis of variance did not differ from the results using a nonparametric Kruskal-Wallis test. When significant differences were found, the Duncan multiple range test was used to group significantly different scores.

Results: The null hypothesis that there is no difference between photographs taken with the various cameras was rejected ($P<.001$) for each of the image attributes. The images produced by the 35-mm camera (Nikon 6006) had the best overall quality, followed by the Olympus D600L, Kodak DCS 315, and Olympus D320L digital cameras. Differences in individual attributes between several of the cameras in each category were statistically significant ($P<.05$).

Conclusions: The 35-mm camera produced the best overall image quality and ranked first for each of the individual attributes analyzed in this study. The Olympus D600L digital camera placed second in overall quality, but there was no statistically significant difference in focus, distortion, and resolution compared with the images generated by the 35-mm camera. The Olympus D600L digital camera also ranked second in color, contrast, and shadow. The Kodak DCS 315 and D320L digital cameras finished well behind the 35-mm camera in most categories. Although the 35-mm photographs were superior to the digital images, the surgeon should also consider other factors before selecting a system for photodocumentation of surgical results.

Arch Facial Plast Surg. 1999;1:276-281

PHOTOGRAPHIC documentation has long been an integral part of facial plastic surgery. Photography allows the physician to compare preoperative and postoperative images. It provides a means to assess surgical successes or failures long after the patient has left the office. It is often priceless in academic and health insurance communication as well as in medicolegal documentation.

The 35-mm camera has been the criterion standard for the facial plastic surgeon. In most practices where close-up images and views of the head and neck are needed, the camera is equipped with a 90- to 105-mm lens with macro capability. These cameras consistently produce good images without significant distortion, which is important in the documentation of aesthetic facial proportions. Most surgeons process the film into 35-mm slides. The resolution of 35-mm film may vary depending on film type and reference source. If prints are required, for example, for submission to medical journals, the color slides can easily be converted into black-and-white prints via an internegative process. The images can also be converted from a 35-mm slide to a Polaroid print in the office with a slide printer. The archiving of these slides can take up considerable space if a practice is sizable.

Digital photography first became available in the 1970s. Since then, digital cameras have become widely available. Instead of film, digital cameras capture im-
SUBJECTS, MATERIALS, AND METHODS

Three standard facial views were taken of 13 subjects (age range, 27-58 years) by one amateur photographer (J.W.C.). Informed consent was obtained from all subjects (10 women and 3 men). There were 10 white patients, 2 African American patients, and one Asian patient. The frames included frontal full face, lateral profile, and animated forehead views, with the subject sitting upright in a Frankfort horizontal plane. Each subject had his or her images taken at one sitting in a room with one overhead fluorescent light and no windows. A tripod was used to steady each camera and the backdrop was a blue canvas.

The 3 views were taken with each of the 4 cameras. The 35-mm camera was a Nikon 6006 (Nikon Corp, Tokyo, Japan), with a Nikon 105-mm f/2.8 macro lens and a Sunpak automatic DX-12R ring flash (Osaka, Japan). A broad spectrum of digital cameras, ranging from an inexpensive low-resolution consumer-oriented camera to a high-resolution professional series camera, was examined. The digital cameras included the Olympus D320L, with an f/2.8 autofocus lens (Olympus Co, Tokyo, Japan); Olympus D600L, with a 36- to 110-mm, 3-inch zoom f/2.8 TTL autofocus lens; and Kodak DCS 315 (Eastman Kodak Co, Rochester, NY), with an IX Nikkor 24- to 70-mm f/3.5-5.6 lens and a Nikon SB-21 ring flash. The individual camera flash systems and the overhead fluorescent light were the sole sources of lighting. The cost and resolution of each camera are shown in Table 1.

The 35-mm slide film (Ektachrome ISO 100; Eastman Kodak Co) used in the Nikon camera was submitted for processing. The digital images were saved as JPEG files on a zip disk. These digital and 35-mm images were then processed into slides at a professional laboratory, assuring that the resolution of the slides would be no less than that of the camera with the highest resolution. The professional laboratory converted all the slides to glossy 5×7-in color prints, similar to those required for publication in many medical journals.

Each color print was assigned a unique random identifying code, which was logged into our data-collection sheet. To our knowledge, there is no validated survey instrument for the analysis of aesthetic facial photographs; consequently, a data-collection sheet was specifically designed for this study (Figure 1). Three facial plastic and reconstructive surgeons who were blinded to the origin of photographs evaluated the prints in a random fashion. At no time were the prints evaluated side by side.

The prints were evaluated for focus, distortion, color, resolution, contrast, shadows, and overall quality of each image. Each answer was recorded and converted to an ordinal scale of 1 through 5, with 1 indicating “strongly disagree” and 5 indicating “strongly agree.”

The data were tabulated and statistical analysis was performed using the Statistical Analysis System (version 6.12; SAS Institute, Cary, NC). Since the sample size was large, we used 1-way analysis of variance to test whether average scores across cameras were significantly different (Table 2). These results did not differ from the results using a nonparametric Kruskal-Wallis test. When significant differences were found, the Duncan multiple range test was used to group significantly different scores (Table 3).

The 35-mm camera had the best overall quality and ranked first for each print feature analyzed in this study (P<.001). The Olympus D600L digital camera ranked second in overall quality (P<.001), but there was no statistically significant difference in focus, distortion, and resolution compared with the 35-mm camera (P<.05). Furthermore, the Olympus D600L digital camera ranked second in color, contrast, and shadow. The Kodak DCS 315 and Olympus D320L digital cameras finished well behind the 35-mm camera in most categories.

Actual samples of the color prints reviewed in the study are shown in Figure 2. Differences in skin pigmentation, hair color, amount of distortion, and detail were noted among images from the different cameras.
The photographer made notes on the ease of usage of each camera during the photographic sessions. The 35-mm (Nikon 6006) and Kodak DCS 315 digital cameras were the easiest to use. The Olympus D600L digital camera was very difficult to focus in the close-up views. Several attempts were often required to focus on the forehead rhytids using the TTL autofocus system. It took approximately 30 to 45 seconds to manually override the autofocus system by moving the tripod away from the patient, holding the shutter release halfway down, locking in the focus, moving back into the desired distance, and then turning a small knob on the back of the camera to manually adjust the focus. This cumbersome process resulted in many images that were out of focus, which required immediate retakes during the same subject sitting. The Olympus D320L digital camera was easy to use; however, because it had no zoom feature, the camera had to be placed uncomfortably close to the patient’s face to properly crop the images. The forehead animated view highlighted the close-up capability and resolution of each camera.

Advancements in digital technology have made a great impact on image acquisition, processing, storage, and retrieval. These developments, which have been primarily driven by the evolution of computer processing power, storage capability, and the Internet, have furthered the progressive use of medical images in practice and education. The technological development of digital image devices now allows a surgeon to objectively document and organize his or her cases. This visual data storage capability will undoubtedly raise the level of surgical practice as innovations are documented and disseminated to a wider audience.

To our knowledge, this is the first prospective randomized comparison in the medical literature of images from a 35-mm camera with those from multiple digital cameras. Although a recent article touches on the question of 35-mm vs digital photography in an aesthetic practice, it was a nonblinded assessment of images from only 1 digital camera. In addition, the article does not mention how the quality of images was assessed and by whom. The authors did provide cost projections for their 35-mm and digital cameras. Although start-up costs can be much greater for a digital system (including a computer with or without an imaging system), ongoing operating costs are greater for a 35-mm camera (eg, film, processing, and storage).

Another consideration in the quality assessment of digital images is the method by which the digital files are stored. In this study, the digital images were stored as

<table>
<thead>
<tr>
<th>Photo Quality Evaluation Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>The image is in focus</td>
</tr>
<tr>
<td>The image is not distorted</td>
</tr>
<tr>
<td>Colors appear true and natural</td>
</tr>
<tr>
<td>Resolution is adequate for clinical interpretation</td>
</tr>
<tr>
<td>Contrast is adequate to examine cosmetic features</td>
</tr>
<tr>
<td>Image quality is not compromised by shadows</td>
</tr>
<tr>
<td>The overall quality of the image is:</td>
</tr>
</tbody>
</table>

Table 1. Cost and Resolution of Camera Systems*

<table>
<thead>
<tr>
<th></th>
<th>Nikon 6006 35-mm Camera</th>
<th>Kodak DCS 315</th>
<th>Olympus D600L</th>
<th>Olympus D320L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost, $</td>
<td>1311</td>
<td>6000</td>
<td>1000</td>
<td>400</td>
</tr>
<tr>
<td>Resolution, pixels (pixels per image)</td>
<td>1524 × 1012 (1.5 million)</td>
<td>1280 × 1024 (1.3 million)</td>
<td>1024 × 768 (0.8 million)</td>
<td></td>
</tr>
</tbody>
</table>

* Ellipses indicate not applicable.

Figure 1. A photographic quality evaluation form was specifically designed to assess image attributes that are important to the facial plastic surgeon.
JPEG files, which are compressed. As a result, there may have been some deterioration of quality in the digital images. However, JPEG is a commonly used method of digital file storage, and the study was designed to reflect the likely practice setup. We are planning to further study digital images with other cameras and storage methods.

In our study, 35-mm photography was judged superior in overall quality to all of the digital devices used. In spite of these findings, and in anticipation of ongoing refinements in technology, a close consideration of the adoption and use of digital photography in a facial plastic surgical practice is still warranted. Several considerations that should be reviewed prior to the adoption or rejection of digital photographic platform are outlined below.

### WHAT IS THE PURPOSE OF THE PHOTOGRAPHY?

An examination of the underlying purpose of image acquisition is fundamental when considering the implementation of a digital platform (Table 4). Is the highest color quality required? Is the highest resolution imperative? If these requirements are mandatory, then a 35-mm platform is currently well advised. If some small compromise in these parameters can be tolerated, with the expectation that ongoing camera and software refinements will in all probability resolve them, then the many advantages of a digital platform should be exploited.

### STORAGE

A digital platform allows for unlimited storage. Gone forever, with this technology, are large binders of slide pages, slide cabinets, and view boxes strewn with hundreds of uncatalogued stacks of loose Kodachrome photographs. More important than an issue of storage space is the phenomenal ability of a digital platform to organize, catalog, and cross-reference images with various digital imaging software packages. High-capacity storage units and advances in storage media allow for large-volume archives of images that span an entire surgical career. A lifetime of photography in a digital format can be transported on several compact discs in a briefcase. Digital images can be copied, labeled, and stored by patient, date, diagnosis, procedure, or outcome. This makes 35-mm slide duplication, which results in diminished image quality of the copy, an unnecessary task and results in significant potential cost savings. Moreover, there is no degradation of image quality with digital storage over time, which is in marked contrast to celluloid-based image storage. Some digital storage media have limited shelf life; therefore, long-term archive data should be stored on permanent media.

---

### Table 2. Univariate Analysis of Photograph Features by Type of Camera*

<table>
<thead>
<tr>
<th>Feature</th>
<th>Nikon 6006 35-mm Camera</th>
<th>Digital Cameras</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.83</td>
<td>3.34</td>
</tr>
<tr>
<td>Overall quality</td>
<td>3.98</td>
<td>3.88</td>
</tr>
<tr>
<td>Focus</td>
<td>3.97</td>
<td>3.82</td>
</tr>
<tr>
<td>Distortion</td>
<td>3.96</td>
<td>3.18</td>
</tr>
<tr>
<td>Color</td>
<td>4.02</td>
<td>3.85</td>
</tr>
<tr>
<td>Resolution</td>
<td>4.05</td>
<td>3.76</td>
</tr>
<tr>
<td>Contrast</td>
<td>4.02</td>
<td>3.80</td>
</tr>
<tr>
<td>Shadow</td>
<td>3.83</td>
<td>3.34</td>
</tr>
</tbody>
</table>

*Values are means; attributes were scored on a photographic quality evaluation form (see Figure 1) and converted to an ordinal scale of 1 through 5, with 1 indicating “strongly disagree” and 5 indicating “strongly agree.”

### Table 3. Multivariate Analysis of Photograph Features by Type of Camera

<table>
<thead>
<tr>
<th>Feature</th>
<th>Rank First</th>
<th>Rank Second</th>
<th>Rank Third</th>
<th>Rank Fourth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall quality</td>
<td>Nikon 6006 35-mm</td>
<td>Olympus D600L</td>
<td>Kodak DCS 315</td>
<td>Olympus D320L</td>
</tr>
<tr>
<td>Focus</td>
<td>Olympus D320L, Nikon 6006 35-mm</td>
<td>Nikon 6006, Olympus D600L</td>
<td>Kodak DCS 315</td>
<td>Kodak DCS 315</td>
</tr>
<tr>
<td>Distortion</td>
<td>Nikon 6006 35-mm, Olympus D600L</td>
<td>Olympus D600L</td>
<td>Kodak DCS 315</td>
<td>Olympus D320L</td>
</tr>
<tr>
<td>Color</td>
<td>Nikon 6006 35-mm</td>
<td>Olympus D600L, Kodak DCS 315</td>
<td>Olympus D320L</td>
<td>Kodak DCS 315</td>
</tr>
<tr>
<td>Resolution</td>
<td>Nikon 6006 35-mm, Olympus D600L</td>
<td>Olympus D320L, Kodak DCS 315</td>
<td>Kodak DCS 315</td>
<td>Kodak DCS 315</td>
</tr>
<tr>
<td>Contrast</td>
<td>Nikon 6006 35-mm, Kodak DCS 315</td>
<td>Olympus D600L</td>
<td>Kodak DCS 315</td>
<td>Olympus D320L</td>
</tr>
<tr>
<td>Shadow</td>
<td>Nikon 6006 35-mm, Kodak DCS 315</td>
<td>Olympus D600L</td>
<td>Kodak DCS 315</td>
<td>Olympus D320L</td>
</tr>
</tbody>
</table>
PATIENT EDUCATION

A surgical procedure is abstract and can be complicated to explain to patients who have no medical back-

ground. Photographs are effective tools that can demonstrate structural abnormalities, procedural details, and surgical outcomes. These images can create realistic expectations on the part of patients who are considering an operative procedure. Additionally, preoperative images can be altered in surgical simulations as a means for patients to anticipate the impact of any given procedure upon their appearance. Although all of the educational enhancements above may be performed on 35-mm images, they can be directly and efficiently incorporated into a digital photography platform. In a 35-mm platform, these images need to be scanned, which results in degradation of image quality and is a laborious process.

PUBLISHING

The current standard for most scientific publishers is submission of 5×7-in glossy black-and-white prints. When color images are desired, these are usually submitted as prints of the same size. A digital imaging system can still comply with these standards through the use of laser printing of digital images onto photographic-quality glossy paper. An example of this process can be seen in the recent medical literature. Some journals are starting to allow the submission of digital image files for article figures, since they can be directly imported into publishing software. With the advent of Internet publishing, the submission of digital images is preferred, since they can be easily imported into Web page design software. The conversion of 35-mm images to a digital format for Internet

Table 4. Checklist of Priorities to Consider in the Selection of a New Imaging System

- What is the purpose of the photographs (office documentation, academic presentations, journal publication)?
- Will good digital photographs, with minimal decrease in color, contrast, and shadow quality compared with 35-mm photographs, be acceptable in your practice?
- What is the primary medium you will use to view your images (computer screen, prints, slides)?
- Do you have a limited amount of storage space?
- Do you frequently access various images to put together presentations or manuscripts?
- Do the convenience and time savings of rapid retrieval of archived images outweigh a compromise in image quality?
- What are the initial start-up costs (camera[s], 35-mm film and film processing, computer, software, printer)?
- What are the projected operating costs of photodocumentation for your office over the next several years?
- Is a digital imaging system with morphing manipulation software critical in your practice?
- Is it more cost-effective given current equipment costs and quality differences to use a separate system for subject photodocumentation and image manipulation?
- Does your office require more than 1 camera (multiple practitioners using the camera systems simultaneously for operating room and office)?

Figure 2. Animated forehead images of one subject with photographs taken using the 35-mm (Nikon 6006) (A), Kodak DCS 315 digital (B), Olympus D600L digital (C), and Olympus D320L digital (D) cameras.
use can cause avoidable image degradation and increased expense and labor.

**ECONOMIC CONSIDERATIONS**

An investment in medical photography is significant regardless of the platform choice. The economics of the 2 platforms are unique to each individual practice situation. We will attempt to outline various items that need to be considered when making a cost-based analysis. The camera purchase is the centerpiece of the photography platform regardless of whether it is digital or 35 mm. The price range of digital cameras ($300-$10 000) is greater than that of 35-mm single lens reflex (SLR) camera bodies without accessories ($250-$1000). There are many fine choices of digital cameras within the price range of SLR cameras. When selecting a 35-mm SLR camera, the cost of lens(es) and a flash system must also be considered. These costs are often twice the expense of the camera body. Most digital cameras, however, have fixed lenses and built-in flashes. While these features do not require the purchase of additional accessories, they limit the camera’s performance in terms of depth of field, focus control, and undesirable shadowing from the fixed-point flash.

Other initial investments pertain to image storage. In the 35-mm format, this can range from the purchase of notebook slide pages to elaborate, custom-designed storage cases with built-in light boxes. Slides can usually be stored in a modest space, but prolific photographers or seasoned surgeons may have slide collections that take up considerable space. Space requirements for slides grow with time, and storage costs can be ongoing.

Digital storage requires a significant initial up-front investment in a computer and peripherals. The cost of these items is continually dropping as capacity increases. For active photographers or practitioners with computerized simulation programs, a dedicated image unit is strongly recommended. Ongoing costs for digital storage include periodic computer upgrades or replacement owing to breakdown or obsolescence. Storage media (disks, tapes, or compact disks) also represent a small but continuous expense.

The practice of 35-mm photography has significant ongoing costs for film, processing, and printing. Unlike digital photography, these functions are largely performed in photographic laboratories. The use of only one roll of film per week can result in an expense of over $600 per year in film and processing alone. The use of this amount of film would seem quite modest for most facial plastic surgeons. Digital cameras do have a film equivalent in terms of memory media (either disks or cards). These media are more expensive than film, but once acquired, they can be used indefinitely.

**CONCLUSION**

The choice of a photographic platform requires the consideration of many factors, including cost, amount of use, and intended uses. Digital imaging technology continues to improve as the cost of these devices declines. To our knowledge, this is the first prospective randomized evaluation in the medical literature of images from a 35-mm camera vs those from multiple digital cameras. Our blinded randomized study determined that a 35-mm camera was superior to the 3 models of digital cameras we tested, although 1 digital camera’s performance was close to and for some image attributes not significantly different from that of the 35-mm camera. The many potential uses of a camera should be carefully considered before selecting a 35-mm or digital photographic platform.

Accepted for publication July 28, 1999.

Presented at the Combined Otolaryngology Spring Meeting, American Academy of Facial Plastic and Reconstructive Surgery Section, Palm Desert, Calif, April 28–May 1, 1999.

The authors gratefully acknowledge the assistance of Ginger Brown, United Imaging Inc, Winston Salem, NC, and Jefferson Camera, St Louis, Mo.

Corresponding author: Mimi S. Kokoska, MD, Department of Otolaryngology—Head and Neck Surgery, St Louis University Health Sciences Center, 3635 Vista Ave at Grand, St Louis, MO 63110 (e-mail: kokoskan@slucare1.slu.edu).

**REFERENCES**