tion thus consists of 2 possibilities: (1) a planned lip adhesion with a definitive repair staged at a later date or (2) surgical setback of the premaxilla. Because of the lack of long-term follow-up, it is doubtful that surgeons on cleft lip mission trips routinely plan a 2-staged lip repair with initial adhesion. Surgical excision of the premaxilla is not advocated because the premaxilla is recognized as the keystone of the maxillary arch. Premaxillectomy in an infant causes flattening or concavity of the midface, loss of support for the upper lip, and failure of forward growth of the nose. The risk of premaxillary necrosis is real when the premaxillary setback is performed with the labial repair. However, in my 2 patients, the premaxilla remained pink and bleeding after the setback.

Surgical setback of the premaxilla is indicated only as a final option. As demonstrated by Friede and Pruzansky,6 the premaxillary-vomer suture is the likely growth center affecting midface, nose, and maxillary arch development. Surgical setback of the premaxilla, if performed before the completion of midface growth, likely places a patient at risk for midface retrusion and a concave profile.6 However, various authors have also suggested that a protrusive premaxilla can be set back after 6 to 8 years of age without deleterious effects on midfacial growth.7

Malnutrition is endemic in Guatemala8 and presents another risk for poor wound healing and potential lip desiccation. For example, nearly 50% of children in Guatemala have low height for their age.9 Inadequate dietary intakes and high rates of infections are believed to be the principal postnatal biological factors that limit children’s growth. A previous analysis of Guatemalan infants’ dietary data indicated low intake of several micronutrients, especially iron and zinc, vitamin B12, and protein.10

In conclusion, patients encountered in the developing world often represent a reconstructive challenge not encountered in the United States. Most of these secondary deformities can reliably be repaired with scar excision, a Mulliken-type repair, and, if necessary, a premaxillary setback.

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An Objective Comparison of 35-mm Film and Digital Camera Image Quality: A New Gold Standard

Many facial plastic surgeons have abandoned film for standardized patient photography because of the lower recurring costs and easier workflow of digital imaging.1,2 Because of these advantages, many authors recommend digital image capture but caution that film is still the gold standard for clinical photography owing to its superior image quality.3,5 Although there is a consensus that film provides a better image than digital imaging, there is some disagreement about the resolution of 35-mm slide film. Ratner et al stated that slide film has a resolution of 4096 × 2736 pixels, yielding an 11.2-million-pixel image. Other authors6-8 disagree, saying that film has a resolution of 15 to 100 million pixels. Several studies9-10 have directly compared the image quality of 35-mm slide film with that of digital cameras. Universally, they have confirmed that 35-mm slide film is the practical benchmark for image quality in standardized patient photography. However, these comparisons had considerable limitations. In each study, the methods used to compare the cameras were not standardized—the cameras used different lenses, the digital cameras had sensor sizes different from that of a frame of 35-mm film, the camera-to-subject distance varied between the digital and 35-mm film cameras, and the images compared were of patients instead of standardized test targets. Also important is that the measurement was subjective—study participants rated varying aspects of image quality (that were never defined) using an ordinal numeric scale. Because so many variables were uncontrolled, it is difficult to draw a meaningful conclusion from these comparisons, and it is impossible to repeat and validate the results. In contrast, this study uses objective measurements of image quality to compare digital and 35-mm film images of a standardized test target. The objective of this study was to objectively compare the image quality of 35-mm slide film and a digital camera.

Methods. Images were captured of an International Organization for Standardization (ISO) 12233 standardized test target, a validated instrument for measuring cam-
era resolution, with a Canon EOS 1n film camera and a Canon EOS 1Ds Mark II digital camera (Tokyo, Japan) (Figure 1).11 Affixed to each single-lens reflex (SLR) body was a Canon EF 100-mm f/2.8 Macro USM lens. Studio monolights with reflective umbrellas were oriented 45° to the test target and affixed to the ceiling. Similarly, both cameras were placed on a locked camera stand, and the cameras and test target were leveled. Both cameras were set to ISO 100, aperture f/8, and shutter speed 1/160th of a second. Mirror lockup was engaged on both cameras to minimize vibration. The Canon EOS 1n recorded the target on Fujichrome (Tokyo) Provia100F color reversal film that was processed in standard E6 chemicals. The Canon EOS 1Ds captured the image on a 24 × 36-mm sensor (the same size as the Provia100F film) at a resolution of 4992 × 3328 (16.6 million effective pixels) in raw image file mode. The raw file was processed by Adobe Photoshop CS2 (version 9.02; Adobe Systems Inc, San Jose, California) generating a tagged image file format (TIFF) document. The Fujichrome Provia100F slide was scanned with a Super Coolscan 4000 ED (Nikon, Tokyo) at 4000 pixels per inch, resulting in a TIFF image with dimensions of 5782 × 3946 pixels (22.8 million effective pixels).

After image capture, the files were processed with Imatest image analysis software (version 2.3.9 Pro; Imatest LLC, Boulder, Colorado) to measure the subjective quality factor (SQF). Subjective quality factor is a way to measure the perceived image resolution that accounts for the inherent sharpness of an imaging system, the specific contrast sensitivity of the human retina, print size, and viewing distance. Measurement of SQF was first described in 197212 and has been shown to correlate highly with the subjective measurements of image quality.13 To measure the SQF, a region of interest (ROI) that included a portion of the slanted edge in the center of the test target was selected. This ROI was 300 × 300 pixels and was from the same portion of the image for both the film and digital files. A total of 4 different ROIs were measured as separate trials to permit a determination of statistical significance. Imatest calculates SQF using the following equation14:

\[ f \text{ (cycles/degree)} = \frac{f \text{ (cycles/pixel)} \times \pi \times n_{PH} \times d}{180 \times PH}, \]

where \( f \text{ (cycles/pixel)} \) is the contrast sensitivity function of the retina, \( n_{PH} \) is the number of vertical pixels in the image, \( d \) is the viewing distance in centimeters, and \( PH \) is the picture height in centimeters.

Each ROI was analyzed unsharpened and with standard sharpening. The standardized sharpening amount is determined by Imatest to optimize edge contrast and may vary depending on the calculated print size.

After processing the test target with Imatest, the measured data were analyzed for statistical significance with Microsoft Excel (version 11.3.5; Microsoft Corp, Redmond, Washington) by performing a 1-tailed, paired t test. Because Imatest's SQF calculation generates a curve based on image print sizes of 3 to 40 cm, the data points...
chosen for comparison were those based on a print height of 25 cm because this is the largest image that would likely be published or placed in a patient's medical chart (Figure 2).

Results. After processing slanted-edge measurements of 4 ROIs, the results of the Imatest analysis were tabulated and are shown in the Table. Imatest reports SQF as a percentage of ideal sharpness. For the uncorrected measurements, the digital images had an SQF of 90.12 to 91.02, whereas the film images were 81.14 to 82.88. The mean (SD) difference between the uncorrected trials was 8.52 (0.56). When standardized sharpening was applied, the range of measurements was 97.75 to 98.65 for the digital images and 93.22 to 94.17 for the film. The mean difference dropped to 4.30 (0.39). A 1-tailed, paired t test generated P values less than .05 for both the uncorrected (P < .001) and corrected images (P < .001). This statistically significant difference supports the conclusion that, when controlling for variations in subject matter, lighting, distance to the target, lens used, and sensor size, digital capture offers superior image fidelity when compared with a 35-mm slide.

Figure 2 shows sample curves for SQF from one of the trials. The dashed lines represent the SQF for the corrected image with standardized sharpening applied as it relates to the printed picture height. The SQF is stated as a percentage of image quality when compared with a theoretically perfect image. The reason that the scale shows values greater than 100% is because of the possibility for oversharpening. Oversharpening degrades the quality of the image, and values significantly greater than 100% are, in fact, worse. Imatest’s standardized sharpening algorithm is designed to maximize the sharpness at all print sizes, ensuring the best possible SQF measurement. At

<table>
<thead>
<tr>
<th>ROI</th>
<th>Unsharpened Digital</th>
<th>Unsharpened Film</th>
<th>Difference</th>
<th>Sharpened Digital</th>
<th>Sharpened Film</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>90.12</td>
<td>81.14</td>
<td>8.98</td>
<td>98.02</td>
<td>93.86</td>
<td>4.16</td>
</tr>
<tr>
<td>2</td>
<td>90.15</td>
<td>81.17</td>
<td>8.98</td>
<td>97.94</td>
<td>93.22</td>
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<td>91.02</td>
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<td>8.27</td>
<td>97.75</td>
<td>93.93</td>
<td>3.82</td>
</tr>
<tr>
<td>4</td>
<td>90.73</td>
<td>82.88</td>
<td>7.85</td>
<td>98.65</td>
<td>94.17</td>
<td>4.48</td>
</tr>
</tbody>
</table>

*The subjective quality factor data points that corresponded to a picture height of 25 cm were used to calculate statistical significance. The mean (SD) difference in values between the digital and film images for unsharpened film is 8.52 (0.56) (P < .001) and for sharpened film is 4.30 (0.39) (P < .001).
the top of the graph, the sharpening radius used is shown. The black line shows the SQF without applying any sharpening. Also listed is the resolution of the source image and the size and location of the ROI. The ROI is shown as a red square on the thumbnail image of the test target. The graph in the lower right shows the modulation transfer function (MTF) of the imaging system in isolation for both the unsharpened and sharpened images.

Comment. Overall, the results of this study support the hypothesis that digital imaging offers a statistically significant improvement in the perceived image quality compared with 35-mm slide film when controlling for variations in subject matter, lighting, distance to the target, lens used, and sensor size. In particular, sensor size is a very important variable whose impact has not been considered in the previously cited studies. When the sensor in a digital camera is smaller than a frame of 35-mm film, the image is recorded using only the central portion of the lens, narrowing the angle of view. This makes standardization of the reproduction ratio difficult and requires that the digital camera be farther from the subject than the film camera. To date, only very few digital cameras have been produced that have sensors the same size as a frame of 35-mm film. These are the Kodak (Rochester, New York) DCS SLR introduced in 2004 (now discontinued), the Canon EOS 1Ds series (2002 to present), the Canon EOS 5D series (2005 to present), the Nikon D3 series (2007 to present), and the Nikon D700.

Previously, objective measurement of image quality was limited to the MTF, which measures the ability of an optical system to transmit detail from a subject to a recording medium. Although this offers some basis for the comparison of 2 imaging systems, it does not account for the characteristics of the human visual system, print size, or viewing distance. Stated another way, the MTF describes the characteristics of an imaging system, whereas the SQF describes the viewer’s perception. Therefore, the SQF is a more practical way to measure the quality of an image.

When interpreting these results, it is helpful to have an understanding of the importance of sharpening an image. Sharpening increases the contrast at the edges of the elements in an image. The standardized sharpening algorithm used by Imatest is designed to optimize the sharpness of an image before processing. Image sharpening is a complex topic beyond the scope of this article, but it is important to realize that more is not always better. Oversharpening an image can have just as detrimental an effect on image quality as undersharpening owing to the creation of artifactual halos. Imatest’s standardized sharpening ensures that each image achieves the highest possible SQF measurement. Figure 2 shows the difference in the standardized sharpening that was applied to each set of images. The film required a sharpening radius of 4 pixels, whereas the digital image needed only a 1-pixel radius. This means that the digital image needed less sharpening to achieve an optimal level of sharpness and supports the conclusion that the original image was already nearly ideal. Figure 3 shows examples of images that are undersharpened and oversharpened compared with one that is optimized. Figure 3B shows an appropriate level of sharpening that maintains detail, maximizes edge contrast, and does not introduce artifacts into the picture. Figure 3A is soft and lacks fine detail. Figure 3C demonstrates the destructive effects of oversharpening. Edge contrast is increased such that halos are created at areas that transition from light to dark.

It is reasonable to wonder if the scanner somehow degraded the image quality of the slide. Figure 4 shows a crop of the scanned image from the film camera. The grain of the film is visible in the scan, indicating that the scanner resolution was not the limiting factor. In addition, the final scanned image consisted of a larger pixel area than that captured by the digital camera: 22.8 million pixels for the slide and 16.6 million pixels for the digital sensor. Therefore, it is unlikely that digitizing the slide had any important deleterious impact on the fidelity of the image.

The purpose of this article is not to disparage 35-mm slide film for use in standardized medical photography. The images produced with slide film are excellent. The small P value should not be misinterpreted as representing a large difference in image quality. It only means that the measured difference between the 2 formats was likely to be real and not the result of random chance. Because digital imaging systems have long-term cost advantages and streamline image storage and retrieval, facial plastic

Figure 3. Examples of images. Images that are (A) undersharpened and (C) oversharpened compared with (B) one that is optimized.
surgeons should not feel that they are sacrificing the quality of their patient photographs for convenience.

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Methods. Rhinobase was prepared using questionnaires, previously published articles, and our experience with both rhinoplasty and computerized patient databases. Its content was prepared by all of us, and then two of us (F.A. and S.A.) developed Rhinobase using Borland Delphi software (version 4.0 for Windows; Inprise Corp, Scotts Valley, California), a popular visual application development environment. (The free, downloadable program setup files are available at http://www.rhinobase.net. Additional information about the minimum system requirements and installation procedures also can be found there.)

The main menu of the Rhinobase includes a frame for the patient’s photograph; patient demographics; and shortcut buttons for clinical history, examination, photographic analysis, operative planning, operation, follow-up, and photographs (Figure 1).

The clinical history window is designed using 5 different frames: complaints, past medical history, family history, past surgical history, psychological status, and outcomes research. This module is of special importance because it provides the surgeon with clues regarding the psychological status of the patient so that the same questions are consistently asked of every patient and no questions are neglected during routine history taking. The examination window incorporates a detailed nasal examination section that includes a dynamic nasal ex-