Aesth. Plast. Surg. 31:194–200, 2007
DOI: 10.1007/s00266-006-0125-5

Aesthetic Plastic Surgery

Original Article

Digital Photography in Plastic Surgery: How to Achieve Reasonable Standardization Outside a Photographic Studio

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Abstract. Accurate photographic documentation has become essential in reconstructive and cosmetic plastic surgery both for clinical and scientific purposes. Digital imaging systems currently are popular, being reasonably affordable and much improved in quality. They offer multiple advantages in terms of quality, easy image storage and retrieval. Nevertheless, obtaining standardized, consistent, and relevant digital images is not easy outside a photographic studio. The purpose of this report is to define guidelines for accurate image capture in different anatomic areas, following elementary general criteria based on practical issues beyond the purely theoretical, to obtain reasonable standardization, consistency, and reproducibility.

Key words: Digital imaging—Guidelines for accurate imaging—Photographic documentation

Accurate photographic documentation has become an essential issue in reconstructive and cosmetic plastic surgery both for clinical and scientific purposes. Photographic standardization according to well-established criteria is required to obtain significant and comparable images.

Digital photography has become increasingly popular for medical image capture. In fact, preoperative planning and visual reference during surgery, critical evaluation of outcomes, data exchange, teaching, publications, and presentations all are facilitated by digital imaging. Moreover advances in this field have resulted in more affordable equipment with advantageous cost effectiveness, as compared with conventional 35-mm camera systems [3,6].

Photographic standards in plastic surgery have already been highlighted in various articles [1,2]. Unfortunately, the suggested technical photographic guidelines oftentimes require advanced skills not common among nonprofessional photographers. A plastic surgeon's everyday activities involve taking consistent and valid photographs despite technical and environmental limits. Although standardization is easy if surgeons have the advantage of a photographic studio setup, image capture on a ward or in an outpatient clinic is not as consistent in terms of photographic standards.

This report aims to define simple and applicable guidelines for acceptable image capture of different anatomic areas with reasonable standardization, consistency, and reproducibility.

Methods

On the basis of the medical literature and our own experience, we report general criteria concerning patient preparation and positioning as well as camera setting. Specific criteria for image capture within different anatomic areas are then discussed.

General Criteria

Patient Preparation. Whenever the face is photographed, the hair must be set so as not to cover the face. Jewels, glasses, and hearing aids must be removed. Makeup is not allowed, especially in cases of skin resurfacing procedures (e.g., laser, dermo-

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abrasion, peelings). All garments that interfere with poses and visibility of the area must be removed.

Background. The background must be an even, nonreflecting, monochromatic surface. White or light blue panels on walls or the backs of doors can be adapted in places where photographs are to be taken. A white or light blue drape can be held behind the patient by an assistant.

Camera Settings. Two main types of digital cameras are available on the market: single-lens reflex (SLR) and compact cameras. The latter differ from the SLR camera, which has a mirror enabling the viewfinder to see directly through the interchangeable lens. The SLR digital camera is excellent for photographing indoor, low-light, and action subjects. A fixed focal length of 35 to 70 mm guarantees an undistorted image, considering that the focal length of the human eye is 50 mm. The photographer is obliged to stand at a distance from the subject that allows correct image capture within the preestablished anatomic boundaries, and this is an ideal condition for achieving standardization [8].

Unfortunately, SLR-style digital cameras are about twice the size, twice the weight, and twice the price of compact digitals, and generally are used by expert photographers. Compact cameras are easy to use, not cumbersome, practical, and therefore the most common among plastic surgeons. We refer to them, considering the purpose of this article.

Most compact digitals do not have a fixed focal length, so it is not possible to achieve standardization, as with SLR cameras. The more closely the subject is approached, the more the risk there is of distortion. The patient must be positioned at a distance from the camera, which varies the extent of the anatomic site to be included in the picture. Generally, it is advisable to maintain the camera more than 1 m away from the patient, taking advantage of the zoom. The zoom is a type of lens that allows the operator to vary the focus. Its use is especially advantageous for photographing details. It in fact increases and reduces the field angle, allowing optimal capture of details. Only the optical zoom should be used, which is easily feasible in cameras that indicate activation of the digital zoom, allowing it to be avoided if necessary.

The other parameters on the camera should be selected manually after assessment of the environmental light with an exposimeter, which is not always available. We suggest selecting the "P" function, which automatically determines the appropriate white balance and ISO (sensitivity) in accordance with the flash.

In photographing details, namely subjects up to 8 cm in size, at a close distance, and in taking close-up views, it is mandatory to take advantage of the macro function. The use of rulers in the vicinity of defects or skin lesions helps to indicate actual dimensions. The focal point corresponds to the center of the subject at the center of the picture, and is unchanged when zooming is used. The camera must be placed at the same level as the focal point of the anatomic region being shown.

Illumination. Illumination must guarantee optimal definition of anatomic details and must be reproducible. In a photographic studio, lights are fixed, which is certainly advantageous. The patient is placed 50 to 90 cm from the background, at the center of a virtual triangle. Standard conditions for obtaining the best definition of surface details without shadow are offered by the following:

- Two lamps at 45° with respect to the patient on a plane parallel to the frontal one.
- One light from above in a sagittal plane perpendicular to the frontal one aiming downward (or two lights at a 45° angle with respect to the subject).
- One light behind the patient on a plane parallel to the frontal one aiming forward and at a distance of 30 to 60 cm from the background so as to detach the patient from the background, thus highlighting surface details.

Lamps currently in use tend to overheat, and this can cause chromatic change in the light emitted, which results in images not comparable although captured under seemingly identical conditions. A type of light termed "cold light" provides good illumination without overheating, thus avoiding the aforementioned risk. Antireflex devices and light-diffusing umbrellas (soft box) can make illumination more homogeneous. Unfortunately, the surface of the subject also will appear more homogeneous, and this can cause detail loss.

Outside a photographic studio, ideal illumination is not easily attained, especially in restricted areas, such as outpatient clinics or operating rooms, where a flash is required most of the time. This supplementary light has a fixed exposure and shutter speed. Once it is switched on and automatically operated, its use does not require other procedures. Care must be taken to position the camera correctly, which is essential to avoid shadows, depending on the position of the flash with respect to the lens. In fact, with the most common digital cameras, it is appropriate to capture the image of an anatomic site with a greater horizontal diameter, maintaining the camera horizontally.

Conversely, vertical subjects are photographed with the camera kept in a vertical position such that they are easily included in the vertical rectangular frame of the picture. This rule does not hold true when the flash is used, except in the case of annular flashes, whose illumination is independent of the camera's orientation and characterized by a low working distance (flash-to-subject) using the macro function.

It generally is correct to keep the camera horizontal, with the flash on top, in taking frontal views, even of vertical subjects, so as to standardize illumination, with the light always coming from above. On the contrary, for lateral and oblique views, it is necessary to turn the camera so that the flash is on the side corresponding with the photographed detail. In this way, for example, when pictures of the face are taken, shadows are not produced by projection of the forehead, nose, and lips. Keeping the subject set off from the background helps to avoid shadows as well.

An alternative to the flash is adequate environmental illumination, with the same series of shots taken under consistent conditions. Care must be taken because different conditions of illumination, highlighting surface irregularities, can mimic a preoperative–postoperative effect.

Specific Criteria According to Anatomic Area

Face. Views:

- *Frontal view:* From the upper limit of the head to the "jugular incisure," with the patient looking at the camera (Fig. 1a). The line that runs from the right and left tragions (upper edge of the tragus) to the lowest point on the lower edge of the orbit (Frankfurt plane) is horizontal.
- *Oblique view (right and left):* From the frontal view, with the patient's whole body rotated 45° so as to align the tip of the nose with the cheek outline. Care must be taken to leave a narrow stripe of cheek to set off the nasal tip from the background. The Frankfurt plane is held horizontal. The patient looks ahead (Fig. 1b).
- *Lateral view (right and left):* From the frontal view, with the patient's whole body rotated 90° so as to align the nasal tip and chin. The head must be in its anatomic position with no lateral inclination, neither flexion nor extension. The Frankfurt plane is held horizontal, and the contralateral eyebrow is not visible. The patient looks ahead (Fig. 1c).

Images must be captured asking the patient not only to assume a neutral face expression, holding a relaxed and natural head position, but also to assess mimic muscular contraction (Fig. 1d).

Nose. Views:

- *Frontal view:* The upper limit is the hairline, and the lower limit is the laryngeal prominence. The vertical axis of the face must be perpendicular to the horizontal plane, which is attained by checking eye and ear symmetry as well as by holding the Frankfurt plane horizontal. A lateral slant of the head can convey a false image of the nose, concealing or enhancing its deviation.
- *Oblique view (right and left):* The patient rotates 45° with the whole body so as to align the tip of the nose with the cheek outline, leaving a narrow stripe of cheek to set off the nasal tip from the background. The Frankfurt plane is held horizontal, and the patient looks ahead. This projection, seen by the patient in the mirror, is essential for assessing supratip deformities.
- *Lateral view (right and left):* The patient rotates 90° from the frontal view. The tip of the nose is aligned with the forehead and chin. The ear must be included in the picture. The Frankfurt plane is held horizontal, and the contralateral eyebrow is not visible. Both sides are to be photographed.
- *Basal view:* The head is bent backward so as to align the nasal tip with medial canthi on a horizontal plane. The frontal eminences and chin are points of reference. This view allows assessment of the nostrils, the nasal base, and tip deviation.

Other views advised:

- *Cephalic view:* From above, with eyebrows aligned horizontally. This view helps in assessing minor deviations of the nasal pyramid. The background is the same as for the other views.
- *Lateral view with the patient smiling:* This view helps to show the dynamic relation between the nasal tip and the upper lip, giving information on changes in the nasal tip according to movements of the mouth, depressor septi muscle activity, and projection of the anterior nasal spine.

Eyelids. Views:

- *Frontal view:* The same view as for the whole face to show asymmetry, wrinkles, and the like.
- *Frontal close-up view:* The upper margin is the eyebrows, and the lower margin is the malar arches. The lateral canthi must be included. Eyelid mobility is to be documented. Pictures are taken of the patient looking up, looking down, and with closed eyes.
- *Oblique close-up view (right and left):* Patient at 45°. The patient looks ahead, up, and down. These views allow thorough assessment of lower eyelid bags. The camera is horizontal.
- *Lateral close-up view (right and left):* Patient at 90°. The camera is horizontal. This view showing the position of the eyeball relative to the zygomatic bone is essential to establish whether the vector, according to vector theory, is positive or negative. The vector is the line that runs from

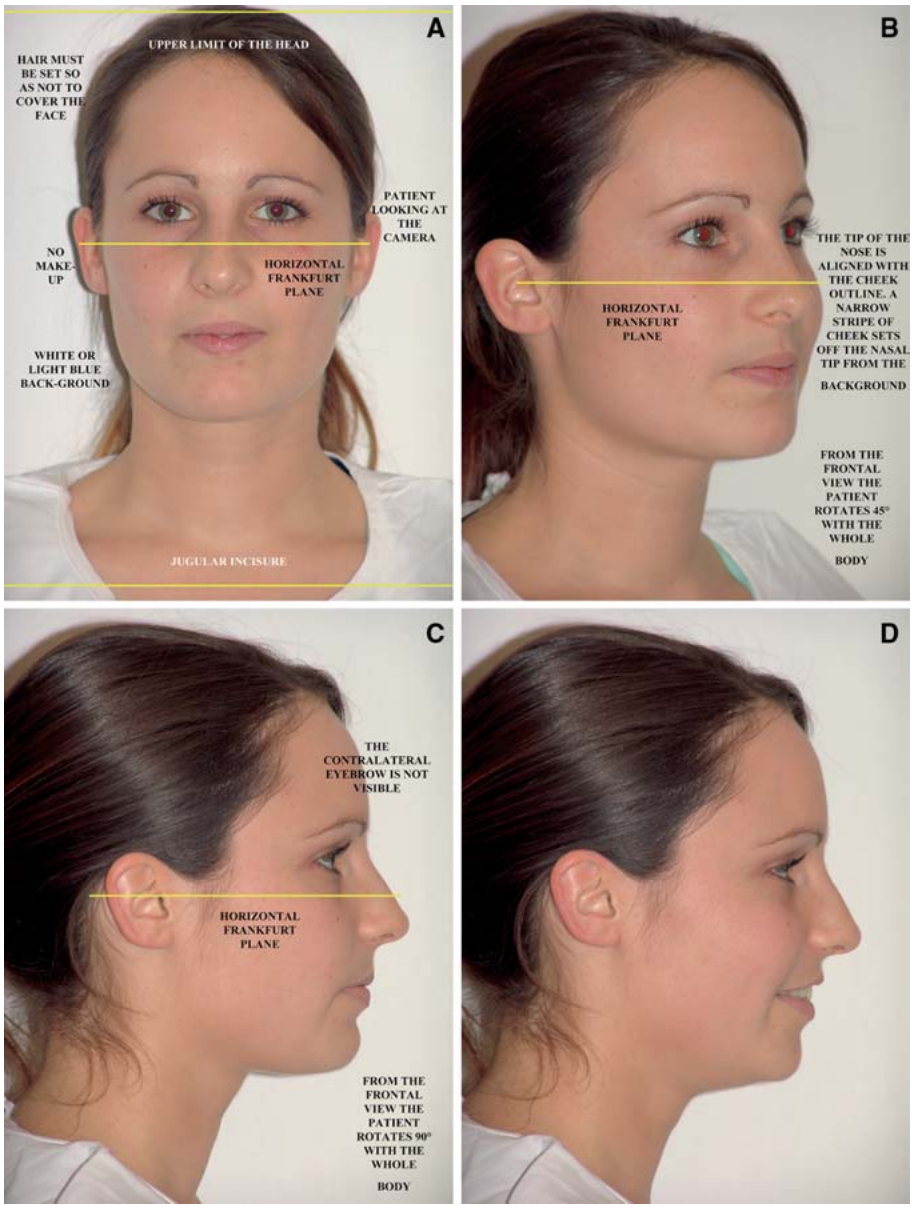

Fig. 1. (**a**) Face: frontal view. (**b**) Face: right oblique view. (**c**) Face: right lateral view. (**d**) Face: smiling right lateral view.

the most prominent point of the eyeball to the malar bone. Its position is considered relative to the vertical plane tangent to the malar bone. If at the level of the eyeball the two planes are more than 4 mm apart, the vector is positive. If the distance is less than 4 mm, the vector is negative. This view allows assessment of the upper eyelid lateral fat pads as well.

Ear. Views:

- *Frontal view:* The same view as for the whole face. This view allows asymmetry of the ear position to be assessed.
- *Posterior view:* This view permits the width of the cephalic–auricular angle to be assessed.
- *Lateral view:* Assessment of all anatomic structures (helix, antihelix, concha, tragus, and earlobe). The vertical axis of the ear should be approximately parallel to the outline of the nose.
- Oblique view: Patient at 45°, the same as for the whole face.

Breasts. Views:

- *Frontal view:* The upper margin is the clavicles and shoulders, and the lower margin is the line running between the anterosuperior iliac spines. The patient is in the upright position, with arms relaxed behind the back and one hand holding the contralateral wrist. This view allows for evaluation of symmetry, shape, and dimensions (Fig. 2a).

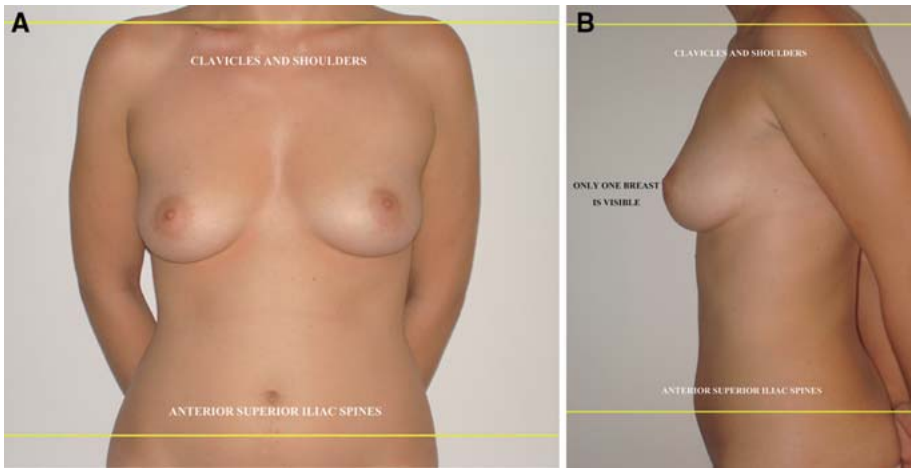

Fig. 2. (**a**) Breast: frontal view. (**b**) Breast: left lateral view.

- *Oblique view (right and left):* The patient rotates 45° from the frontal view. The upper and lower margins remain the same.
- *Lateral view (right and left):* The patient rotates 90°. Points of reference are the same as for the oblique view. Only one breast is shown (Fig. 2b).

Other views advised:

- *Frontal view with arms raised and hands placed over the head*: This view allows symmetry of inframammary folds to be assessed.
- *Frontal view with hands on flanks:* Contracting pectoral muscles. The points of reference are the same as for the standard frontal view. This view permits assessment of mammary gland adherence to the underlying muscular fascia, revealing such pathologic adherences as observed in tuberous and tubular breasts. It also helps in assessing the position of mammary implants, whether submuscular or not.

Hand. Views, always including the wrist:

- Dorsal view
- Volar view.

In particular cases, further views are advised:

- Dorsal or volar view with fingers adducted
- Dorsal or volar view with fingers slightly abducted
- Dorsal or volar view with clenched fist
- Dorsal or volar view with only the third, fourth, and little fingers extended.

Fingers. Views, always including the fingertips and metacarpophalangeal joints, with fingers slightly abducted for assessment of medial and lateral outlines:

- Dorsal view
- Volar view.

Abdomen. Views:

- *Frontal view:* The upper limit is the inframmary fold, and the lower limit is the junction of the upper and medial thirds of the thigh. The arms are relaxed behind the back, with one hand holding the contralateral wrist.
- *Oblique view (right and left):* The patient rotates 45°. Points of reference remain the same.
- *Lateral view (right and left):* The patients rotates 90°. Points of reference remain the same.

We advise the following views as well:

- *Frontal view with arms raised over the head:* Points of reference are the same as for the standard frontal view. This view allows for assessment of asymmetry during movement.
- *Lateral view with trunk bent more than 45° (diver's test):* This view is used to assess the musculo-aponeurotic relaxation in the lower abdominal quadrants.
- *Frontal and lateral views during Valsalva manuever:* This view is used to show abdominal hernias.

Posterior Trunk. The upper limit of this view is the neck's lower limit, whereas the lower limit is the buttocks' upper limit. The patient stands in the anatomic position.

Flanks and Thighs. The upper limit of this view is the umbilicus, and the lower limit is the knees. The patient keeps his or her legs adducted in the anatomic position for the following views:

- Frontal view
- Anterior oblique view (right and left)
- Lateral view (right and left)
- Posterior oblique view (right and left)
- Posterior view.

Other advised views:

- Frontal view with slightly abducted legs to show thigh medial contour
- Posterior view with the patient on tiptoe to assess gluteal and thigh contour during muscular contracture
- Posterior view during gluteal muscular contracture.

Legs and Feet. The upper limit of this view is the patella, and the lower limit is the toe tips. The patient stands erect with legs adducted for the following views:

- Frontal view
- Lateral view (right and left)
- Posterior view.

Discussion

Digital technology has reached high levels of quality, with its usage becoming dramatically more widespread in the medical–surgical field over recent years. Most surgeons have switched to digital photography in consideration of its undeniable assets. It is extremely advantageous for archiving, storing, and retrieving images in terms of time and space. Computerized database management facilitates data retrieval. Its main limits are represented solely by hard disk capacity and usage of peripheral units (e.g., CD ROMS). Furthermore, the computerized storage and data transfer eliminate the need for transporting loads of photographs.

It should be underscored that digital image quality seems to remain unchanged over time, as compared with the inevitable decay of paper or slide format. Placing pictures on an Internet site as well as attaching them to an email or to a multimedial presentation (e-learning) also is much easier than traditional lengthier and more inaccurate scanning.

The digital format offers undisputed economic advantages by reducing expenses relative to film purchasing, developing, and printing. Immediate visualization of pictures on the liquid crystal display (LCD) screen allows deletion of the undesired images, avoiding the cost of useless prints, as with traditional photography. Image visualization represents a means of communication with the patient as to operation planning and goals.

The evolution of photo editing software has emphasized the need for standardized image capturing. Pictures, if not standardized, must be modified to be comparable with images in similar formats. However, image manipulation could threaten the very truthfulness and guarantee of image standardization, with all the ensuing consequences (impossibility of comparison and unreliability of results, publications, and presentations), as well as image reliability for medical–legal and insurance purposes. This is why various software products capable of identifying manipulated images and their artifacts have been introduced on the market.

It is evident that the establishment of common criteria would lessen the necessity for image modification, although it has been emphasized already in the medical literature that different digital cameras perform differently. The discrepancies in contrast and color are mainly attributable to image processing, and the differences in ability to capture image detail are mainly due to resolution [4,5]. We note that different monitors and different printers impinge on image standardization.

In this report, we aim to provide elementary general criteria on the basis of practical issues beyond the theoretical that are applicable with any average digital camera. The parameters stated for the background and illumination are easily reproducible whatever the operating setting. Camera orientation, horizontal or vertical, is suggested according to the flash position.

Specific criteria have always included well-established anatomic boundaries.

They ensure assessment of the subject's most significant details, which are reported as in an ideal clinical examination conducted by a specialist surgeon.

Considering the nasal pyramid, a complete set of shots will have to draw attention to the following:

- *Dorsum:* deviation, base width, nasal bridge height
- *Tip:* shape, definition or lack of definition, superficial flaws, the relationship between columella and alar cartilages, nasal base width
- *Outline:* dorsum slant, root position, irregularities, tip projection, nose length, columella–lobule angle, root height and shape, columella protrusion, crura length and position
- *Base:* nostril width, shape, and symmetry; columellar width; nostril lobule relationship; soft triangle; previous surgical scars
- *Frontal full face view:* This view is essential for determining the relationship between the nose and other facial anatomic structures.

Views during movement (e.g., patient smiling) are useful for evaluating details more evident when emphasized by muscular action. These details are important for the overall preoperative evaluation. Pictures then can become an integral part of the patient's clinical record [7], just as an x-ray, and can be modified only in terms of cutting off insignificant details or enlarging picture size, with all other parameters remaining unchanged. Pictures also can be used for operation planning and during the operation as a visual reference.

"Morphing" is a computer-based process that uses a digital picture of the patient and a sophisticated

software program to create a new, refined image. The surgeon highlights the area to be changed and makes slight adjustments until the desired effect is shown. This system conveys a clear idea of what can be achieved and shortens the patient's decision time as it helps the patient to understand what can be expected from the surgery.

Nevertheless, the use of photo editing to show the patient the planned operative outcome is a procedure that must be executed only by very competent operators. It should be borne in mind that an image manipulated to such an extent as to simulate a virtual postoperative outcome can be interpreted by the patient as an implied promise of a result. Unfortunately, the software can never be exact because tissue changes are not incorporated into the image. Moreover, morphing could even be misleading for the patient during evaluation of the preoperative clinical status and planning of the operation if attention is drawn only to certain features. Accurate explanations should be given with regard to tissue changes and scarring, and a disclaimer should signed by the patient. In this way, the described misunderstandings can be avoided. Morphing is undeniably a precious tool for communication between surgeon and patient.

Conclusions

The central role of photography in the clinical and educational areas of plastic surgery implies adoption of an acceptable level of standardization. The less an image is manipulated, the more reliable it is. Implementation of the simple general and specific criteria proposed allows reasonable standardization of image capturing on behalf of personnel with no particular proficiency in photography.

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