Review Article

Basics of digital photography in Dermatology*

*Fundamentos da fotografia digital em Dermatologia**

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Abstract: *Digital technology has promoted a great popularization of photographic registration in several medical areas. Because of its visual nature, dermatology has incorporated the benefits of this tool in clinical practice and research. This article aims to offer guidance to the dermatologist who is unfamiliar with this technology, providing basic understanding for the best use of digital photography equipment.*
Keywords: Dermatology; Methods; Photography

Resumo: *A tecnologia digital promoveu grande popularização do registro fotográfico em diversas áreas médicas. A dermatologia, por sua natureza visual, vem absorvendo os benefícios dessa ferramenta na prática clínica e na pesquisa. Este artigo visa orientar o dermatologista não familiarizado com essa tecnologia, oferecendo noções para o melhor uso do equipamento de fotografia digital.*
Palavras-chave: Dermatologia; Fotografia; Métodos

INTRODUCTION

Since the morphologic characteristics of lesions are so closely related to their diagnoses, dermatology is considered a specialty with a significant visual component and this has favored the development of iconographic representation techniques.

The Image Department of the SBD (Brazilian Dermatology Society) encourages photographic documentation in dermatology practice, encompassing care, teaching, and research. Digital technology has caused a reduction in costs and an increase in versatility and productivity, and has popularized the use of photography in this specialty.

It is important to point out that dermatological photography, unlike artistic photography, values features of reality and verisimilitude, i.e., characteristics that allow accurate recognition of the documented lesions at any time.

This article aims to guide the dermatologist who is unfamiliar with this technology in the best use of digital photography in his specialty.

DIFFERENCES BETWEEN DIGITAL AND TRADITIONAL PHOTOGRAPHY

Digital technology has modified the concept of photographic recording. In this way, the photochemical registry that used to occur on film was substituted by an electronic sensor that transforms different light intensities into digitalized signals that are later stored in a computer file. Even so, the body, lens system, mechanical structure, and photographic techniques used with a digital camera are not any different from those of traditional photography.[1]

Each luminous point of the image captured by the electronic sensor is called a pixel, and the ordered arrangement of pixels with different intensities of color form the digital image.

Every pixel concerns one intensity of red, green, and blue (RGB system – Red, Green, Blue), and their combination results in one color of the light spectrum, varying from black (absence of color) to white (maximum intensity of R, G and B color).

Each registered pixel is codified by a topogra-

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phic location on the photographic image and one color intensity. This codification allows image editors to modify these codes and effect changes in digital photographs, and permits researchers to carry out measurements such as calculations of distances, areas, color intensities, and recognize patterns in digital images.

The total number of pixels of a digital photograph is called its resolution. In this case, the greater the number of pixels (greater resolution), the greater the dimension of the recorded image, number of perceived details, and size of the computer file generated.[2]

Therefore, a pixel is the elementary structure that forms a digital image.

TYPES OF DIGITAL CAMERAS

Digital cameras can be divided into compact and professional cameras, and their choice should be based on technical knowledge and intended use, at least for a period of several years.

Compact cameras have evolved in their capacity as to photometry, focusing, resolution, macro function, and control of photographic parameters such as diaphragm opening, obturator speed, film sensitivity, among others. These are the models most dermatologists acquire because they are practical, portable, and offer a good cost/benefit ratio.[3]

Nevertheless, the lack of control of the flash intensity in macrophotographs, effects of the light incidence from the flash, difficulty of focusing closer than 10 cm from the lesion, manual control of the focus, and shorter durability are some of the factors that speak against the choice of compact equipment.

Professional cameras (SLR – Single Lens Reflex) are generally more durable and allow one to change objectives and filters, and couple different types of flash, lenses for dermoscopy (such as the Dermaphoto™, utilized for dermoscopic photos) and adapters in order to obtain ultraviolet photography, and there are no limits for skin lesion documentation. Greater camera and accessory costs, more photographic controls, and greater weight and size are elements that can discourage the decision to purchase a professional camera.

Technological innovations result in a periodic launching of innumerable new camera models by their manufacturers, leading to the rapid obsolescence of digital equipment. These factors enhance the need for adequate technical knowledge for a careful purchase choice based on the desired type of photography.

Chart 1 shows the main digital camera makers and their institutional sites where the technical specifications of each commercialized camera model and its accessories can be consulted.

It is important to point out that the choice of camera should live up to the dermatologist's expectations as to use of the equipment.

MINIMUM REQUIREMENTS FOR DERMATOLOGICAL DIGITAL PHOTOGRAPHY

Several essential factors for the appropriate use of dermatological digital photography should be considered before purchasing digital equipment.

1. Lenses

In spite of modern polymer technology, crystal lenses still outperform the acrylic lenses used in many compact cameras.

In photographing dermatological lesions, the use of large size amplification relative to the original lesions or the approximation of the camera to the skin is possible with the use of macrophotography.

In professional digital cameras, the choice of 75-110 mm macro objectives has proved to be adequate for clinical practice. For technical reasons, the use of 12-25 mm lenses in compact models may offer very satisfactory results for the dermatologist.[4,5]

A macro function option can be activated in compact cameras through the camera's commands allowing a focus distance of less than 50-80 cm, which is what most dermatological photos use. There are also less compact digital cameras with a macro function superior to that of other compact models that uses a minimum focusing distance of 5 cm or less.

Another low-cost resource used in close image documentation is the use of close-up lenses that are adapted to the objectives and allow a greater approximation, in spite of risks of defocusing and chroma-

CHART 1: Main manufacturers of digital cameras (alphabetical order)

Manufacturers	Site on Internet
Agfa	http://www.agfahome.com
Canon	http://www.canon.com
Casio	http://www.casio.com
Fuji	http://www.fujifilm.com
HP	http://www.hp.com
Kodak	http://www.kodak.com
Konica / Minolta	http://www.konicaminolta.com
Kyocera / Yashica	http://www.kyoceraimaging.com
Leica	http://www.leica-camera.com
Nikon	http://www.nikon.com
Olympus	http://www.olympus.com
Panasonic	http://www.panasonic.com
Pentax	http://www.pentax.com
Samsung	http://www.samsung.com
Sony	http://www.sony.com
Vivitar	http://www.vivitar.com

tic aberrations on the periphery of the photograph.

Hence, dermatologic photographs with a greater proximity should be made using the macro mode (or objective).

2. Flash

Photographic quality in dermatology can be increased with the use of flash, and there is a great variety of models that offer different technical applications.[5] Compact cameras have built-in flashes that usually cannot be calibrated for use with small distances, and this can result in luminous hyperexposure. Nonetheless, the incorporated flashes prove to be adequate for most dermatology recordings; even so, the choice of an auxiliary flash allows greater flexibility in terms of ways of representing lesions.[1,6]

Another unfavorable situation that occurs in macrophotographs that use a flash incorporated to the camera is the effect of light angulation, resulting in a unilateral shadow on the image obtained.

Many compact digital cameras can also have external flashes units installed by means of an adapter (hot shoe), increasing the options for quality control of the photograph by the user.

Annular and twin flashes characterize the most versatile external auxiliary equipment for photographing skin lesions, but their technical features transcend the objectives of this article.

The "red eyes reduction" option should be disabled for dermatological photographs since in photos using the macro mode there may be defocusing or even tremors when the preliminary flash is activated.

In summary, the flash should always be a valued parameter in dermatological macrophotography.

3. Zoom

Given the characteristics of photography in the context of dermatology, proximity to the patient makes the zoom a less utilized feature, in favor of approximating the camera itself. Even so, it is preferable to use the optic zoom that is enabled by moving the lenses; the digital zoom should be disabled for use in dermatology since it can result in loss of photographic quality. In some digital cameras, use of the macro feature achieves good automatic focusing only if no amplitude of zoom is used.[1]

Overall, approximation to the image using an optic zoom of up to 30-40% (1.3-1.4) is used in order to reduce the luminosity of the incorporated flashes that cannot be regulated for macrophotography, as well as to reduce deformities of prominent areas of skin salience such as the nose.

Therefore, we point out that dermatological photography, when necessary, should be employed using only the optic, and not the digital zoom.

4. Resolution

The choice of resolution for the photographic record should take into consideration the intended use of the photograph: filing, teledermatology, classroom presentations, printing/developing, scientific publications, posters, Internet homepage, and research, among others.[7]

There are no irrefutable arguments in any of the abovementioned cases in favor of routinely using more than 2 Mpx (1 Mpx = 1 million pixels), and the decision of using lower resolutions may represent an important advantage for filing, transferring, and editing the photographs.[4,8]

Most multimedia projectors available on the market have a projection capacity lower than 1.4 Mpx, i.e., even if photographs with greater resolutions are selected, the conventional projections of these images will depend on the capacity of the projector. In this way, the preparation of a presentation for a classroom setting or a clinical case with higher resolution (over 3 Mpx) images results in a processing overburden and can slow down the presentation without rendering the quality that a larger number of pixels might suggest.

Chart 2 presents suggestions of minimum resolutions adequate for printing on photographic paper or scientific publications, according to the final size desired.

One controlled study did not demonstrate differences in prints of skin lesions with point densities of 200 or 300 dpi (points per inch).9 The production of posters or banners can be less rigorous (100 dpi) in terms of the need for high resolutions because of the distance from which they are read.

In both cases, the choice of a 1.3 Mpx (1,280 x 960 pixels) resolution proves to be sufficient and for this reason has been adopted as the standard at the Department of Dermatology and Radiotherapy of the Faculdade de Medicina da Unesp in Botucatu.

As an example, one might question what the maximum amplification possible would be in the size of a printed 1.3 Mpx (1280 x 960 pixels) photograph using 1000 dpi as a minimally acceptable limit of visual resolution. In simple terms, we know that 100 dpi equals approximately 39.4 points per centimeter. If the photo has 1280 pixels in its horizontal axis and 960 pixels in its vertical axis, it could be represented as measuring 32.5 cm wide and 24.4 cm high.

On the other hand, whenever there is certainty prior to taking the photography that the image will need editing to remove an undesirable aspect or to concentrate attention solely on one element of the photo (surgical operations, details, background visu-

CHART 2: Maximum printing size (in photographic paper) per chosen photographicresolutions (150dpi quality)

Resolution	Maximum printing size
800x600 (0.5Mpx*)	10x15cm
1024x768 (0.8Mpx)	13x18cm
1280x960 (1Mpx)	15x21cm
1600x1200 (2Mpx)	20x25cm
2048x1536 (3Mpx)	24x30cm
2240x1680 (4Mpx)	30x40cm
2560x1920 (5Mpx)	35x45cm
3000x2000 (6Mpx)	40x50cm

*Mpx: Megapixel (1Mpx = 1 million pixels)

al pollution, trimmings), a greater-than-standard resolution should be used considering that a significant quantity of pixels will be discarded.

In this way, bearing in mind that high resolutions do not necessarily mean an increase in photographic quality, it is possible to state that dermatological photographs, in daily practice, can be recorded with the minimum resolution of 1.3 Mpx.

5. Compression

Digital images can be saved in files of different formats. The inherent difference in these formats is the degree of data compression, generating files of different sizes.

An image originally captured by digital camera is represented by a large file with no compacting (RAW format file) that is difficult to manage, edit, and transfer. For this reason, cameras use efficient image compression systems.

Several computed algorithms are used in compressing digital images; some of them are 'lossless', meaning that they do not cause any loss in photographic quality, such as .TIFF (Tagged Image File Format) and .PNG (Portable Network Graphics) files.[2]

The most widely used, however, are .JPEG (Joint Photographic Experts Group) files, considered 'lossy' since they result in a certain degree of quality loss in photographs in favor of a greater reduction in the resulting file size. This loss of quality is almost imperceptible, except if the photograph is amplified, and it depends, of course, on the degree of compression used.[10]

Compression can be controlled by selecting the type of image file desired and the quality of the compression (with .JPEG this normally varies from one sixth to 1/40th of the original file size). In most cases, control of the image quality (compression) in the camera does not refer to the percentage of file size reduction, but to linguistic terms for quality, such as best, high, or fine, indicating minimum compression; normal, standard or medium, referring to intermediate compression; or basic or low, indicating greater compression.

JPEG compressions up to 1/20th of the original size can represent photographic images adequate for printing, visualization, transfer, and editing.[11]

6. Other elements

Most digital photography cameras work with a range of more than 16.7 million colors (24 bits of color depth equal 2^{24} colors), which surpasses the discriminatory capacity of the human eye and can create results comparable to those of conventional films.[12,13]

Technology for capturing a fourth color layer, adopted by some manufacturers, may increase the discriminatory capacity in the perception of contrast and saturation details in the image.

On the other hand, colors of photographs may suffer interference from local lighting (surgical lamp, fluorescent light, poor lighting), and need appropriate calibration of the white balance and of the use of flash in order to correct this nuance. Even compact cameras have satisfactory automatic compensation lighting systems, and some even allow calibration of the most verisimilar level of white based on the focus of white sheet of paper under the photo's ambient lighting.

The liquid crystal visor (LCD) is one of the most important elements of digital photography because it not only facilitates framing the object to be shot, but also gives an idea as to the final aspect of the photo even before it is recorded. Another fundamental function of the LCD is the immediate visualization of photographs after they are recorded, allowing them to be redone if the results are not satisfactory.

Small dimension or low-resolution LCD cameras make it difficult to visualize the focus plane and many times produce unpleasant surprises seen on the computer screen. One of the reasons for the commercial success of some compact cameras in detriment of other similar brands was the adoption of LCD with more than 2 x 2 inches (more than 5 x 5 cm).

Digital cameras present an automatic focus feature that should be enabled by the user to facilitate automatic adjustments and lock the focus before shooting. This is done by pressing the click button halfway, and this technique should be assimilated by the used in order to achieve better quality photographs.

The energy source for digital cameras may be a rechargeable battery or a set of rechargeable Ni-Cd batteries, conventional alkaline or non-alkaline batte-

ries (the latter ones are not preferable because of their low autonomy), or alternate current adaptors furnished by the manufacturers. Some of these devices can be recharged directly by the digital camera (some batteries) or may demand separate rechargers.[1]

Consequently, when purchasing a digital camera it is important to be attentive to the autonomy of the number of photographs and the practicality of recharging these devices.

Another factor that must be considered in digital photography is the type of media on which the recorded images are stored. While several cameras have internal memories, the use of memory cards has prevailed in the digital industry, besides other options in diskettes (practically in disuse), mini-CDs, microdrives, and mini-DVDs.

The type of memory device utilized affects the way in which it will be recognized by the personal computer and the photographic autonomy available since different devices have their own connectors and drivers for linking up to the computer, as well as different storage capacities.

One should take into consideration, therefore, functionality, storage capacity, and accessibility of the memory device according to the computer in use and work circumstances.

Digital photography cameras may produce small digital films with audio, but just as digital video cameras can generate photographs, poorer control of technical parameters leads to lower quality results than those obtained by appliances developed for this purpose.

Editing the recorded photographs is another important stage of digital technology in dermatology. When used correctly, besides the possibility of accessing every pixel of the image, different strategies for manipulating the photos are also possible. There are several software alternatives with this purpose on the market (Adobe Photoshop™, CorelPhotopaint™, Microsoft PhotoEditor™, PaintShop Pro™, among others).[14] Discussions on techniques for manipulating digital photographs transcend the objective of this article.

It is also important that the user be aware of the fact that, even in digital photography using the .JPEG pattern, there are data incorporated into the file code that contain information about the serial number of the camera, diaphragm opening, velocity of the obturator, resolution, compression, among others. These serve, in fact, as an audit of the authenticity of the photo. These data form what is called the EXIF (Exchange Image Format) metadata and can be lost if a photo is manipulated with certain types of editing software.

It is important to point out that, regardless of the possibility of posterior editing of a photograph, one should get the best possible capture of that particular instant and record it in the most faithful way possible.

PHOTOGRAPHIC TECHNIQUE

Detailed knowledge of how a digital camera works without the use of adequate photographic techniques does not guarantee good quality photographs.

Comprehension and standardization of aspects of framing, composition, background, approach angles, lighting, photometry, field depth, among others should be sought by all dermatologists who wish to improve the quality of their iconographic documentation. In this way, good dermatological photography is born out of careful planning before technological considerations.

There is abundant literature (related to conventional photography) and courses given during scientific dermatology events that cover these aspects.[1,6,15]

Finally, digital dermatology photographs should be recorded using the best possible photographic technique.

FILING / BACKUP

Digital cameras are appliances destined for photographic recording and do not represent an adequate system for filing photographs. Photographic files should be transferred as soon as possible to the computer, where they are stored, cataloged, and ultimately deleted and edited, emptying the camera memory for a new series of photographic recordings.

The appropriate structures for organizing digital photographs on the computer are image data banks that can be integrated with clinical recording systems such as electronic medical charts. There are several commercial systems appropriate for dermatology available on the Brazilian market.

On the other hand, photograph-organizing systems can be obtained free, such as the Adobe Photoshop Album Starter Edition 3.0™ (http://www.adobe.com). Some software programs that accompany digital cameras allow the recovery of photographic files according to previously informed characteristics.

Periodic safety copy back-ups are important since personal computers are subject to defects, thefts, frauds, damage, or invasions. Chart 3 lists the storage capacities of different digital media.

If possible, the stored backup files should be copies of the original images, i.e., not submitted to any editing, even if the image were renamed or reoriented. This care is important in audits for authenti-

city verifications of the digital photographs.

CD and DVD burners are the most utilized for backups, and the media should be stored in a safe place, away from the computer and duly labeled.

IMAGE DIGITIZING

Digitizing is a good alternative to the effects of time and damage from storage in devices or photographs printed on paper. Common table scanners are capable of digitizing photographs on high quality paper, and one should use 24 bits of color depth and resolutions of up to 500 dpi.[9]

Use of slide scanners is a more efficient form of digitizing slides. Purchase cost of these appliances should be considered in light of their future use, since many companies outsource these services. A significant technical recommendation can be based on the use of at least 24 bits of color depth and a resolution between 500 and 700 dpi.[9]

Photographs and slides stored in this way can be reedited by software with no loss in quality, and they should be re-dimensioned (100 dpi) for routine expositions such as classroom presentations and posters, among others.

ETHICAL AND LEGAL ASPECTS

The popularization of digital photography and the simplicity and low cost of this registration form favor an increase in the number of photographic documentations in dermatological practice. At the photography sector of the Department of Dermatology of Unesp, in Botucatu, the inclusion of digital technology has lead to an increment of more than 80% in the number of annual photographs of patients.

The image of a lesion documented during the consultation, as a representation of true clinical information, is considered an integral part of the medical chart. In this way, its recording, use, modification, deletion, or exposition should be authorized by the patient or his legal representative, preferably in writing, even if this is done in the medical chart itself.[16,17]

One should remember that the exclusive use of digital photography as judicial evidence can be contested with the argument that electronic manipulation is easily done – except when the detailed clinical record in the medical chart is substantiated by digital photography with its a authenticity duly certified.[16]

CHART 3: Main memory or storage devices or media

Device	Memory capacity
Disk	1,4Mb*
Memory cards+	16Mb-8Gb**
MiniCD	150Mb
CD-ROM	650-700Mb
DVD-ROM	4.4-5.2Gb

*Mb: Megabyte; **Gb: Gigabyte;
+ Smartmedia, Memory SD, Compactflash, Memory-Stick, Multimedia, Pix-Card, Minidrive

OTHER USES OF DIGITAL PHOTOGRAPHY

Beside recording patients' lesions in clinical practice and dermoscopy and the possibility of manipulation and composition of photographs, educational use, simulation of procedures (surgical operations), and use in teledermatology, digital photography has become an important tool in quantifying variables in applied research. 18-28 Its use in measuring linear dimensions and areas, in quantifying colors, in recognizing patterns, in automated counts, and in comparative texture measurements constitute other applications that are beyond the scope of this article.[2,29,30]

CONCLUSION

Photographic documentation in dermatological practice has been facilitated by digital technology. Diligence in employing the best possible photographic techniques and detailed knowledge of the camera functions have progressively led to the increase in quality of photographic recording and its clinical verisimilitude. ❑

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