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CONVERSION OF SLIDES AND NEGATIVE FILMS TO DIGITAL IMAGES

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Most professional photographers probably want to orientate their professional engagement towards digital photography, and the same may be also said for those who use photographic films (temporary, at least), and it is quite certain that there are people with large collections of very useful conventional slides.

Nevertheless, some professionals are still hesitating regarding the use of professional digital photography.

The paper aims at informing the professional public about numerous advantages of digital over conventional-analogue images, and especially about the methods of conversion of slides and negative films to digital images.

Digital dental photography has numerous advantages over analogue photography and is synonymous with modern dentistry. In addition to the above, it does not eliminate completely negative and positive films, but enables their conversion into a digital form as a safer, more practical, and more cost-effective form for their storage. *Acta Medica Medianae 2011;50(2):43-48.*

Key words: *digital dental photography, positive film, negative film, scanners*

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Introduction

Photography has different meaning for each of us. For some, it is a privilege and a possibility to capture a certain moment of time, while for others it is a means of preserving a memory of some special event in life.

Some people use photography as a means of artistic expression, design, and communication, while for some others it is a means of providing their daily bread. However, for most people, photography is an enchanting hobby – a magical interaction of art and science to be used in almost any situation (1,2).

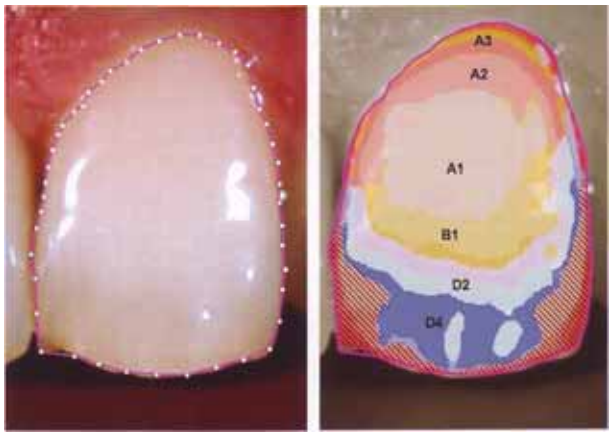
Advantages of digital over analogue photography

Numerous literature information and reports from everyday practice have confirmed the claims of the manufacturers of digital cameras about the advantages of digital over analogue photography, both from the point of view of image quality (sharpness, contrast, vivid reproduction of colors etc., providing for valid documentation of dentistry materials, dentist/patient/dental technician communication, self-validation (control) of one's own results, conversion of negative and positive (diapositive) films into a digital form as a safer and more practical form of data storage, illustration of lectures and publications, in effective marketing), and its cost-effectiveness (there is no need for a film developing laboratory) and speed and ease of image capturing, their repetition if required, and sending over large distances, forming thus the basis of electronic telemedicine (i.e., teledentistry) communication (2-5).

Moreover, the visual method of determination of color of patients' teeth comparing it with a color standard (a pattern of available colors) in the fabrication of fixed prostheses is still widely used in dentistry practice, in spite of its many shortcomings and possible sources of error (6).

Nowadays, however, more objective and more effective are instrumental methods of analyzing tooth color using digital images. In fact, photographic films, television cameras, digital cameras, and scanners can be used to record color-related information, and combined use of digital photography and sophisticated colorimetric examination determined the development of the process of color measurement in dentistry. The above methods/devices provide a detailed image of the tooth surface and useful mapping of color, enabling thus a complete adjustment of color of artificial crowns to the color of adjacent natural teeth (7,8) (Picture 1,2).

Picture 1.



Picture 2.

Technologic innovations in medicine, more precisely in modern pathology, have enabled complete slide digitalization, offering a wide range of precisely defined technical aspects of as high as 31 different systems of virtual, i.e. digital microscopy (9). After an hour's scanning, digital slides of top quality can be obtained, to be used in precise diagnosis, effective (rapid) communication and consultation of the leading experts in the field, forming of a digital archive, professional education of doctors, quality assurance, analysis of case reports, and improvement of scientific-research activity (10).

Digital slides make possible the longevity of conventional slides and elimination of possible problems related to their damage, deterioration and loss of image quiality as the consequence of color alteration and fluorescent signals. Future systems should improve the technical aspects such as scanning speed, required bandwidth in communication networks, data storage requirements, user interface (different from that in conventional microscopy), focusing, detection of tissues and cytologic regions (11).

Many systems for slide digitalization are not suitable for use with polarized light (detection of amyloid and crystals), but in the near future most of them will be improved via the incorporation of necessary filters.

Finally, one more conditional shortcoming of the existing systems for slide digitalization is their high market price (9,11).

Methods of conversion of analogue images to digital ones

Film negatives are used for making photographs, and positives (slides) to be viewed on slide projectors. Color positive films have been termed „professional" for years, since these photographs are better than those made from negative films. Even today, the Fuji slide film „Velvia" has got a cult status among the people who believe that none other film (let alone digital images) can convey the intensity and richness of color (1,12).

Many dentists have high quality conventional photo cameras, while others do not have enough time to use the advantages of digital photo-graphy, and there are even those who are still waiting for the price of digital cameras to drop significantly (13).

In professional literature, three methods of converting analogue to digital images have been mentioned: CD image, photographs of slides and negatives, and slide scanning (14,15).

The first method has been rarely used for dental photographs. It has been patented by the renown company Kodak Picture CD (16), and it makes use of a special software for viewing and use of converted images.

Photographs of slides and negatives

This method requires a special device – slide duplicator – to digitalize slide films or negative films from 35 mm to 6 x 7 cm formats (Picture 3, 4) (1,15,17).

The reliability of the method depends primarily on the quality of digital camera (the use of professional SLR* devices is desirable – Single Lens Reflex, with a single optical light path, enabling a photographer to see the exact image that will be captured by the film) and appropriate positioning of the framed slide or negative film on the slide duplicator. High quality digital images can be obtained in half the time, and that is the reason why many users prefer this method to scanning with a special slide scanner (15,18).

Two alternative variants of the method have been described. One of them requires a box for slide viewing and black cardboard or professional mask to hide the field around the slide (Picture 5). A digital camera is mounted on a special tripod stand with possible vertical sliding of the camera carrier, providing the stability and eliminating even minimal movement of the device. Masking the field around the slide before photographing prevents the entrance of the light reflected from the box through the objective and thus consequential contrast reduction on the captured image.

Picture 3.

Picture 4.

The other variant, similar to the first, implies the use of a slide storing box (Picture 6).

Both variants produce poorer results compared to the quality of obtained digital images using special high quality slide scanners (16,17,19).

Scanners

Scanners are here the devices for conversion of photographs into digital images, whether the photographs are on photo-paper, negative, or positive films. For image scanning on a film, an adapter is required or a dedicated film scanner.

The device with an adapter can be used, but the quality of digital images is commonly insufficient. Best results are achieved with film scanners (Picture 7). Commercially available, at a reasonable price, are the scanners made by NIKON, MINOLTA, CANON, MICROTEK etc., mostly for 35 mm films (1,19). Scanners for larger formats are very expensive.

Picture 5.

Picture 6.

The selection criteria,describing the quality of a device, are its price, resolution, and scanning speed. Scanner resolution is expressed in dots per inch, „dpi"; even the cheaper scanners have 2700 dpi, markedly more than enough to capture the details from any scanned material.

In practice, however, mechanical and optical characteristics of a scanner are much more important than its resolution. One of the properties of specialized photo-scanners is their dynamic range or Dmax range of illumination to be recorded by a device. A film has a wide range of illumination, so that higher dynamic range of a scanner is an advantage. High quality flatbed scanners have Dmax of maximally 4, while film scanners have 4.2 or more. The difference in these values may seem negligible, but it can produce a significant difference in scanning quality, i.e. recording of the details in deep shade and in the lightest parts of negative films or slides (1,20).

Picture 7.

High quality scanners are connected to desktop computers via the USB 2.0 or FIRE WIRE IEEE 1394 cables. After the proper connection has been made, the procedure of slide scanning is as follows:

- The slide scanner shoulds be turned on before the computer is started. After it has been started, the scanner automatically performs its self-calibration for several seconds.
- Adobe Photoshop (or some other photo-editing program) is started.
- Go to File > Import>Scanner>.... (the one installed).
- Place the slide into the scanner. The slide should be clean, without a glass frame, to be placed horizontally, with the emulsion surface turned downwards and glossy surface upwards.
- Scanning software is open; some basic selections are made (film type, slide, or negative, color space).
- Press „Preview" to preview the image/sample.
- Adjust the scanning program (see the scanner manual).
- Press „Scan".
- The scanned image will appear in the Adobe Photoshop window, open for editing, if required.
- Close the scanner interface window and save the obtained file or scan some more slides.
- Do not forget to remove the slide after scanning.
- In addition to scanning indivudual slides, there are devices on the market capable of scanning strips of negatives or group scanning of a number of slides in a single session.

Scanning resolution has to be very high (2700 dpi or more, with top models reaching 4000 dpi), since slide dimensions are small and have to be magnified several times.

Mode 8-bit/mode 16-bit

Good scanners offer the option of 16-bit operation. For average slides the difference will not be impressive; however, the difference will be apparent if the curves of color and tone have been previously adjusted (21). The following procedure is recommended:

- Slide scanning in 16-bit mode as a TIFF file.
- Color and tone adjustment.
- Change the mode to 8-bit.
- Save the final image as a JPEG file.

Example for offset printing

If we want to make a 8 x 10 inch print from a 35 mm film, and it is necessary to print at 300 dpi for the best results, we know that a digital image of at least 2400 x 3000 pixels is required. Since the physical frame dimension of 35 mm is somewhat smaller than 1 x 1.5 inch, we would have to scan the film at 2400 dpi or higher resolution in order to get optimal results regarding print quality.

Example for PC monitors

If we want to use the image from a PC display, we would have to know its resolution or we should apply the usual resolution for best results. If we assume that most users use 1024 x 768 display resolution, we would want to make 1024 x 768 display resolution of our image for desktop background or full display resolution. For e-mail use, image resolution may be less than 512 x 384 pixels. In the table, image dimensions in pixels, megapixel resolutions, file dimensions, and print dimensions at 300 dpi for scanning results of mounted slides from 35 mm at different scanning resolutions are given. All the figures are of average mass from slide mounting with square film window of 35 mm. Scanning of negative films will be somewhat higher.

Image magnification

Good programs for image quality improvement after scanning offer certain techniques. Described in the literature as the one demonstrating good practical results, the technique using infrared light in the film scanning process is able to identify and remove physical defects on the film, such as emulsion scratches and defects. Since the emulsions of Kodakchrom and black-white films are completely or mostly non-transparent for infrared light, the technique can be successfully used with these films (21).

One more technology, termed Digital ROC (digital restoration of color), is specially designed to restore the color and tone of old, faded films (losing the color via the removal of original color information) (13,21).

Picture 8.

A huge advantage of slide scanner devices is a high degree of operational independence compared to other methods of conversion of slides to digital images.

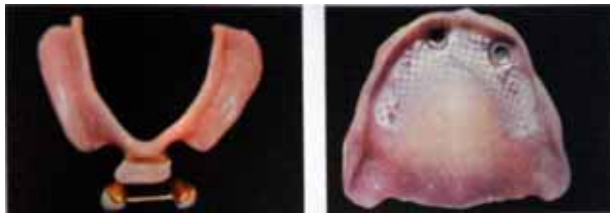
Flatbed scanners and drum scanners

Certain flatbed scanners are commercially available, with the unit of transparency enabling slide scanning (Picture 8). In principle, it is an adapter in the form of special scanner cover, enabling uniform diffusion of light through a slide film or negative film. Generally, the resolution of these scanners is lower than that of dedicated slide scanners. Tests have shown that the quality of photographs in some cases is inferior compared to the quality achieved by slide scanners; this is further confirmed by our results illustrated by Pictures 9, 10, 11 and 12. The reason for that are probably the scanning results reaching sometimes the physical resolution stated in the flatbed scanner manual. Flatbed scanners are cheaper, they are able to scan and print the scanned images, offering the level of quality that can satisfy most users.

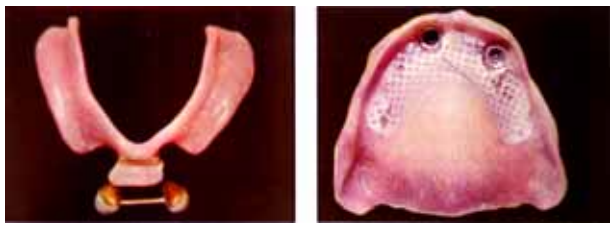
Optimal results can be achieved using drum scanners and photomultiplier tubes. These tubes offer the highest scanning results with a very apparent contrast of light details and details in the shadow. Their dynamic range (DMax range) is so high that they are able to capture the details in deep shadow and very bright light, as well as the differences in all tone nuances. The resolution of these scanners reaches even 12.000 dpi. They are very expensive and used in specialized institutions and lithographic companies which have softisticated IT personel and IT technologies applied (22).

Picture 9.

Picture 10.



Picture 11.



Picture 12.

Conclusion

Digital dental photography has numerous advantages over analogue, conventional images and is rightfully an integral part of modern dentistry. In addition to these facts, it does not eliminate completely negative and positive films, but instead, it enables their survival converting them to digital records as a safer, more practical, and more cost-effective form of data storage.

The quality of converted images necessary for the advantages to be fully exploited will depend both on the quality of hardware devices – a professional digital SLR camera and high resolution scanner – adequate knowledge of the technique (procedure), and taking into account the results and experience of others in the field.

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KONVERTOVANJE SLAJDOVA I NEGATIV FILMA U DIGITALNE SLIKE

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Većina profesionalnih fotografa verovatno želi da usmeri delokrug svoga rada ka digitalnoj tehnici snimanja. Isto tako, ima profesionalaca u tom domenu koji koriste fotografski film, makar privremeno, i sasvim je izvesno, ima onih ljudi koji poseduju veliki broj konvencionalnih slajdova sa bogatom sadržinom.

I pored toga, za pojedine profesionalce još uvek ima opravdanih razloga za oklevanje kada je u pitanju primena profesionalne digitalne fotografije.

Cilj rada bio je da informiše stručnu javnost o brojnim prednostima digitalne fotografije nad konvencionalnim-analognim snimcima, a posebno o metodama konvertovanja slajdova i negativ filma u digitalne slike.

Digitalna dentalna fotografija ima mnogobrojne prednosti nad analognom i s pravom predstavlja sinonim savremene stomatologije. Ona, pored navedenog, ne eliminiše u potpunosti negativ i pozitiv film, već omogućava njihovo konvertovanje u digitalni zapis kao bezbedniji, praktičniji i ekonomski opravdaniji oblik arhiviranja. *Acta Medica Medianae 2011;50(2):43-48.*

***Ključne reči**: digitalna dentalna fotografija, pozitiv film, negativ film, skeneri*