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Digital Photography Trends in Clinical Orthodontic Practice

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I. Introduction

In current years, clinical photography has grown to become a very important diagnostic aid and proper permanent time-linked clinical record which are not only used for diagnosis and treatment planning but also for communicating with the patients about the existing problems, available treatment options and visualization of end results by using various software meant for showing predictable changes with the treatment[1].

When captured correctly, dental photographs will provide more correct evidence about malocclusion and possible treatment options than any other clinical record. The errors most often encountered in clinical photographs can be distributed into two groups.

The first group comprises of errors that result from an inappropriate selection of photographic equipment-the camera, lens, flash, backdrop, and auxiliary equipment such as mirrors and retractors. The second group of errors comprises incorrect patient-operator positioning[1].

The benefit of digital cameras is the instant, digitized accessibility of photos with image quality surpassing that of traditional photography. Similarly, images can be instantly included into a practice's software and stored for future reference.

A novel innovation in the field of dentistry called photogrammetry through which the geometric properties of objects can be determined from photographic images and has proved its effectiveness in studying the three-dimensional occlusion of dental arches, teeth and their dimensions in dentistry.

Digital images can be effortlessly stored and kept for possible use for legal or academic purposes. Hence, digital cameras must be considered as indispensable tools for dentists. It is time academics and policymakers promote photography in dentistry education and incorporate its use in undergraduate and postgraduate studies[2].

Ceib Phillips in 1984: published that a method called photocephalometry has been described for the possible evaluation of orthognathic surgery patients by superimposition of coordinated cephalograms and photographs. The assumption behind this technique is that the photographic images. Can be enlarged so that metal markets placed on the patient's skin are accurately superimposed on the corresponding radiopaque images on the cephalogram. The benefits of this method would be twofold 1) a more detailed visualization of soft tissues in the frontal and lateral vies and 2) a more accurate analysis of soft – to- hard tissue relationships. Particularly of soft tissue thickness. This additional information on soft tissue changes with orthognathic surgery would be valuable in overcoming the inability of standard cephalometric techniques to adequately quantify soft-tissue alterations, especially from the frontal view[3].

Lewis Claman 1990: Published in his article that the photography is becoming an increasingly important tool in the dental profession. But documentation of orthodontic or orthognathic treatment with pretreatment and post treatment photographs can be misleading if features on one or both photographs are distorted. The dental photographer must be constantly aware of the importance of standardizing photographic variables when documentation of change is important. Although total reproducibility may not be practical, the photographer can establish a reasonably standardized approach to photographing patients. In this article the authors presents the major considerations for frontal and profile facial photographs. Lens selection, camera position, subject distance and position are all variables to be under stood and controlled if accurate reproduction is desired. Numerous frontal and lateral photographs were made with head position camera position, jaw

position and lens focal length changed to allow assessment of their contribution to the final picture using easily recognized facial land marks, dental photographers can standardize frontal and lateral portraits for more consistent comparison[4] .

BASIC PHOTOGRAPHY TERMS

Image Resolution

Resolution describes how much detail an image can hold. An image's resolution is determined by the image's pixel count and the bit depth of each pixel. A pixel is the smallest discernible element in an image. Each pixel displays one color. A pixel's color and brightness range is determined by its bit depth. Pixels are grouped together to create the illusion of an image. As the number of pixels increases, the image's detail becomes sharper. A camera's resolution is calculated by the number of megapixels (millions of pixels) its digital image sensor iscapable of capturing. A display's resolution is expressed in pixels per inch (ppi) or as a maximum dimension, such as 1920 x 1280 pixels. A printer's maximum resolution is expressed in dots per inch (dpi)— the number of dots it can place within a square inch of paper. The number of megapixels a camera is capable of capturing can be used to roughly determine the largest high-quality print that the camera is ultimately capable of producing[5].

Focal Length

An important attribute of a lens, besides its quality, is its focal length. Focal length is technically defined as the distance from the part of the optical path where the light rays converge to the point where the light rays passing through the lens are focused onto the image plane—or the digital image sensor. This distance is usually measured in millimeters. From a practical point of view, focal length can be thought of as the amount of magnification of the lens. The longer the focal length, the more the lens magnifies the scene. In addition to magnification, the focal length determines the perspective and compression of the scene[5].

The Exposure Triangle

1. **Aperture,**
2. **Shutter Speed**
3. **ISO**

When these three elements are combined, they represent a given exposure value (EV) for a given setting. Any change in any one of the three elements will have a measurable and specific impact on how the remaining two elements react to expose the film frame or image sensor and how the image ultimately looks.

1. Aperture

A lens's aperture is the opening in the diaphragm that determines the amount of focused light passing through the lens. At a small f-stop, say f/2, a tremendous amount of light passes through, even at a fraction of a second; but at f/22, when the diaphragm is perhaps at its smallest, only a tiny amount of light is let in (even at longer shutter speeds).

"F" Number & Depth of Field

The F number basically refers to the aperture opening size on the lens. The smaller the F number, the larger the aperture opening and the shallower the depth of field of the image is, ie, less and less parts are in focus. The larger the number is, the smaller the aperture and more depth of field exists i.e: the photo is sharper throughout

2. Shutter Speed

Shutter speed refers to the amount of time the shutter is open or the digital image sensor is activated. The exposure of the image is determined by the combination of shutter speed and the opening of the aperture. Shutter speeds are displayed as fractions of a second, such as 1/8 or 1/250. Shutter speed increments are similar to aperture settings, as each incremental setting either halves or doubles the time of the previous one. For example, 1/60 of a second is half as much exposure time as 1/30 of a second, but about twice as much as 1/125 of a second.

3. ISO

ISO stands for International Standards Organization. The ISO rating, which ranges in value from 25 to 6400 (or beyond), indicates the specific light sensitivity. The lower the ISO rating, the less sensitive the image sensor is and therefore the smoother the image, because there is less digital noise in the image. The higher the ISO rating (more sensitive) the stronger the image sensor has to work to establish an effective image, which thereby produces more digital noise (those multi-colored speckles in the shadows and in the mid-tones). The

digital camera engineers have designed the image sensor to perform best at the lowest ISO (just like with film). On most digital cameras this is ISO 100, although some high end DSLRs have a mode that brings the ISO down to 50 or even 25[5].

CLINICAL REQUIREMENTS

Digital Camera

The ideal camera setup that is best-suited and recommended for clinical photography is a Digital Single Lens Reflex camera setup (DSLR) with a suitable Ring Flash unit. The minimum accepted image resolution that would provide us with high quality photos for screen presentation or 4x6 prints - if desired - would be around 4 Megapixels. However, current cameras can produce much higher-resolution photos than this minimum requirement, therefore it can be generally determined that any current camera with a resolution of 8 Megapixels or higher would be more than adequate for orthodontic record-taking purposes.

Lens

A dedicated Macro lens attached to a DSLR camera provides even better close-up photos usually with higher definition and better focus, and is by far the superior choice. Although zoom lenses can generally be used for clinical photography, the recommended lens to use is a dedicated Macro lens e.g. a 100mm focal length Macro lens.

Flash

Ring Flash v/s Point Flash

The Single Point Flash built into most compact digital cameras and some DSLR may occasionally produce fairly good light distribution when used for clinical photographs, but the results are very inconsistent and largely depend on camera orientation and pre-existing lighting conditions in the clinic. Dark distracting shadows, which may obstruct important details frequently occur. These are often irreparable even by using image editing software, and will detract from the final quality of the image, and possibly the information gained from it.

A dedicated Ring Flash - eliminates almost all shadows by providing a more even distribution of light during extra and intra-oral photographs, and thus the quality of the image is enhanced due to overall better illumination. Therefore, it is highly recommended to use a Ring Flash for orthodontic photography.

Retractors

Smaller one-piece orthodontic bonding retractors are generally not a good choice for orthodontic purposes, especially for buccal and occlusal shots, as their retraction potential is very limited, and it can often prove to be a painful experience for the patient. It is a wise long-term investment to buy good quality retractors to ensure durability and reliability, with recurrent disinfection procedures.Large, Medium and Small sized Double-ended Cheek Retractors are better.

Dental Photography Mirrors

Many authorities in the field recommend front-coated silvered mirrors as they offer the best image quality and light distribution over other types of mirrors. With front-silvered mirrors, no ghost image, or double-layering occurs. In contrast, when using glass or rear-coated silvered mirrors, ghosting can severely affect the quality of the image, resulting in haziness or a Double-Image.

STANDARDIZATION OF PHOTOGRAPHS

1. Method of Standardization as suggested by Wolfgang Bengel[6]

Photographic apparatus

- 35 mm Single Lens Reflex Camera
- 100 – 135 mm Lens
- Lateral Flash for Extraoral Photographs
- Ring Flash for Intra oral Photographs

Intra oral Photography

Frontal view

- Centre of Frame – at the point of contact between upper central incisors
- Centre of Focus – between canine and first premolars
- Edge of Frame – the lateral edges besides the last molars
- Occlusal plane – parallel to upper or lower edge of frame

Lateral Views

- Centre of Frame – at the tip of the second premolar

• Centre of Focus – at the tip of the second premolar
• Edge of Frame – beside the last molar or at the side of the central incisor
• Occlusal plane – parallel to upper or lower edge of frame
Occlusal View of Mandible
• Centre of Frame – at the intersection of the sagittal plane with the line joining the second premolars
• Centre of Focus – in the lingual sulcusor on the gingival margin of second Premolars
• Edge of Frame – upper or lower edges of the frame should be distal to the last molars and in front of the incisors.
Occlusal View of Maxilla
• Centre of Frame – at the intersection of the sagittal plane with the line joining the second premolars
• Centre of Focus – in the Palate or onthe gingival margin of secondpremolars
• Edge of Frame – upper or lower edgesof the frame should be distal to the last molars and in front of the incisors.

Extra Oral Photography
• Background – it should be harmonious.Generally grey or white background is suitable
• Illumination – photofloods or electronic flashunits
• Position of Mandible – in rest position withlip in resting state and normal relation.
Profile View
• Top edge of the frame should be just above thehead and bottom edge in the region of larynx
• Back of the head need not be included
• There should be an empty area in front of the profile
• Focus should be on the patient‘s eye
• FH plane should be parallel to the top or bottom edge of the frame
• Ear should not be covered by hair
Frontal View
• Top edge of the frame should be just above thehead and bottom edge in the region of larynx
• Focus should be on the patient’s eye
• Inter pupillary line should be parallel to the topor bottom edge of the frame.

2.Method of Standardization of Intra oral Photographs as suggested by HielkeBrouwer and A. Jan Van Hillegondsberg[7].
Routine intraoral photography
For standard front and lateral intraoral views the following settings are used:
• Exposure time — 1/60 second.
• Focal distance — infinity.
• Lens aperture — f22.

3.Standardization of Intra oral Photography by Ross G. Kaplan[8]
• Use of Point source of illumination
• Use of Buccal or Occlusal mirrors oriented 450 to occlusion or occlusal surface of teeth andcamera oriented 450 to mirror so that resultant image would be at 900 to the occlusion.
• Area being photographed should occupy sameposition in frame each time.
•The orientation of camera to the teeth beingphotographed should be consistently reproducible.

4. Standardized Extra oral photography by Lewis Claman et. al[9].
Head position
• Photograph should encompass – Crown of head to clavicle
• Camera to subject distance should bekept constant
• Inter pupillary line should be parallelto horizontal plane
• Distance from outer canthus tohairline should be equal on each side
• Line from outer canthus to superiorattachment of ear should be parallel to horizontal plane
• For Profile photograph – inner andouter aspect of eye which is onphotographic side should be visible.
Camera Lens and position
• Focal length of lens should be keptconstant (100mm or 105mm)
• Line from middle of lens to eyeshould be parallel to horizontal planeand lens should be centered betweentwo eyes.
Mandibular position
• Photograph must be taken in postural rest position.

RECENT PHOTOGRAPHY TRENDS IN ORTHODONTICS

Dynamic Records[10]

Another method to evaluate the facial norms is to take the dynamic recording of smile and speech with digital videography. Using of this method is widespread in the smile position rather than the rest position.Schabelet al.reported that digital videography method gives us a lot of information for assessing the dynamic properties of smile, but the standard digital photography method is still sufficient for evaluation of smiles after treatment.

Stereophotogrammetry[10]

Stereophotogrammetry is an imaging system that transforms the 2-dimensional images obtained by 2 synchronized camera device to the 3D images with the help of computers, and makes processed the complex algorithms process. The system consists of two synchronized cameras angled at 150° and mounted in a frame 50 cm from within. Time of the image capture is up to 1.5 milliseconds, and the processing time is approximately 30 seconds. The short image capture time especially causes a great advantage for the patient and the physician. High image quality and noninvasive and ionized nature of imaging are advantages. It is a more rapid method according to the laser scanning system, and there are no safety concerns with the laser scanning system in this system.

3dMD Imaging Systems

Recently, especially in the dental clinic, 3dmd (3Dmd, Atlanta, Ga, USA) face system, which is a stereophotogrammetry system, has been started to be used frequently. 3Dmd is a surface imaging system and designed to display a 3D human face. The system provides exact size image with face morphology and linear, angular, and volumetric measurements of the human face. Advanced photography speed with high resolution eliminates image distortion caused by patient movement.

II. Conclusion

Orthodontics and other fields of dentistry should follow technological advances strictly in order to use in practice. Capturing high-quality photos is one of these practices, comprising an important topic in all fields of dentistry. In parallel, photography has become an optional subject in some universities in our country. When advantages of photos captured in the clinic are considered,

1) Routine documentation is achieved,
2) Photos can be used at presentation and comparison of cases,
3) It is important to compare data during long-term follow-up,
4) Standardization of records is important to obtain reliable results, and for comparison of outcomes.
5) Images captured before, during, and after treatment provide legal protection when needed[10].

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