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Review Article

Photography in Orthodontics

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ABSTRACT

A brief history of photography is provided along with a critical appraisal of the different "Camera" and professional system currently available. Recommendation is made as to the system best raised to current Orthodontic practice. The buzz word is digital. The world is going digital. Film less photography, pictures on a chip call it what, this is a new phenomenon of technology. It is big, and it is the way things will be from this day forwards. For over 170 years, photography has been based silver halide film, which is now being replaced. Digital photography has come about as a result of convergence of both IT and Photography. And it has so much to offer us. This article reviews photography in Orthodontics.

Introduction

The word photography comes from Greek word meaning "To write or draw with light." The word "photography" was coined by Sir *John Herschel* in 1839. Photography is the process of making pictures by means of the action of light. Light reflected from an object forms a picture upon a material sensitive to light. This picture is then chemically processed into a photograph; which provides a representation of the object [1]. Current 'best practice' is a full set of extra- and intraoral photographs, both at the start and completion of a course of orthodontic treatment and, ideally, some mid-treatment photographs showing key stages in treatment (Sandler,2000). Photography is recognized as an essential aid in orthodontic diagnosis. Knowledge of photography is one of the required attributes of an orthodontist. Dr. B. W. Weinberger says, "Today modern orthodontia requires not only knowledge of dentistry, but of art, anatomy (both human and comparative), anthropology, biology, embryology, pediatrics, physical diagnosis, psychology, photography, roentgenology, nutrition and many other branches of medicine and allied sciences [2]." What we learn today is because of the clinical photographs, we see in textbooks. These were available courtesy the efforts of those authors. The profession will be furthered, and our next generation will learn if each clinician as a torchbearer of the subject makes that the same effort. Digital photography has been generally available since 1981. In 1991 'Autotrader' were the first mass market publication to move completely to digital recording of images. More importantly, though DSLRs have overwhelming capabilities for orthodontic photography, one needs to learn only three controls (aperture, shutter speed, and International Standards Organization [ISO]).

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History of photography in dentistry

Anderson in 1926 formed a system of photography called as gnatho-physiognomical photographs. The photographs made by this technique were composite of facial photograph with photograph of study models.[3] *B. E. Lischer* in 1933, in his review of requirements of diagnostic aids has placed Facial Photography next in importance to written records. *Tauro M. Graber* in 1946, divided the use of orthodontic photography into two types [4]

1) For diagnostic criteria

2) For record purpose.

Robert E. Binder in 1974, described the uses of lip retractor developed by *Dr. Brainerd Swain,* which was specifically designed for occlusal intra-oral photographs.[5] *William F. Stutts* in 1978, described method of taking extra-oral as well as intra-oral photographs in orthodontic practice.[6] He also described method of duplicating the color slides as well as obtaining black & white negatives from color slides. *Wolfgang Bengel* in 1985 developed a method of Standardization of dental photography which is widely used till date. He proposed fixed distance, canter of frame, canter of focus, edge of frame, and orientation of occlusal plane for each photographic view.[7] *Lewis Claman, Daniel Patton, Robert Rashid* in 1990, described method of Standardization of portrait photography for dental patients.[8] *Marc B. Ackerman and James L. Ackerman* in 2002, presented smile analysis and smile design using digital imaging and computer programs. They concluded that esthetic smile design is a multifactorial decision-making process that allows the clinician to treat patients with an individualized and interdisciplinary approach.[9]

Jonathan Sandler and Alison Murray in 2002 carried out a clinical survey regarding use of clinical photography. They concluded that the need for intraoral and extraoral photographs was important and a minimum data set of 18 photographs (pre-treatment and post treatment) for each and every orthodontic patient.[10] *Edward H. Angle* devoted chapter II (8 pages) to "*Facial art—line of harmony*." He referred to the profile of the statue of Apollo Belvedere as "a face so perfect in outline that it has been the model for students of facial art." He discussed his "line of harmony," a vertical line that touches glabella, subnasale, and pogonion in the profile "with perfect harmony." In the seventh edition, published in 1907, the chapter on "Facial art" was increased to 28 pages, a reflection of the importance *Dr Angle* placed on the subject. Angle assumed that the faces in Grecian art conform to the Apollo type because "the blood of the people was pure, comparatively free from admixture with races of different types." In dentistry photography has its different platform, there a numerous use of this science some of which are –

To store records, to compare pre-operative and post- operative changes, useful in diagnosis, documentation and patient management, Patient education, In dental curriculum, Tele-dentistry, Medico-legal purpose etc.

Clifford L. Freehe stated that, "It is important to make your pictures sing loud, clear and clean. If they do, everyone will sit up and take notice. A lecture on dull subject or an average

paper can be brought to life with quality images. Quality photograph results do not just happen. One must make them happen".

Equipment's and Techniques

Equipment's and techniques for photography depend upon the method of photography used. The methods of photography used in dentistry.

A) Conventional or Standard or Film Photography

B) Digital Photography

A) Conventional or Standard or Film Photography

In conventional photography, film is used as a receiver which records the image seen on ground glass or view finder. Conventional photography has evolved from traditional large sized cameras and ground glass to miniature film cameras with view finder or LCD (Liquid Crystal Display) screen.

B) Digital Photography

The field of Photography was revolutionized with the Advent of Digital photography. Instead of film as a receiver, it utilizes CCD (Charged Couple Device) as a receiving medium, and therefore there is no need for developing film. Rather, the image is directly transferred to the computer and print out can be taken or print out can be directly taken through the camera without transferring it to computer.

Equipment's required for photography are listed as follows: -

1. Camera Body
2. Lens
3. Flash unit
4. Film (for Film photography)
5. CCD/ CMOS
6. Storage Media (for Digital Photography)
7. Mirrors
8. Lip Retractors

Requirements for clinical camera –

- It must be a top-quality instrument.
- It should be a single lens reflex type.
- It should be compact.
- It should be versatile.

Classification-

Cameras can be classified in several ways:

a) T*auro M. Graber* [11] in 1946 classified cameras available at that time into five types-

1) Reflex type cameras

2) Miniature (35mm) cameras

3) Specially designed cameras

4) Stereocameras

- Reflex type cameras

The main advantage of the "see what you take" reflex type camera is that there is no pause after setting the bellows and lens.

- Miniature (35mm) cameras

These cameras are small in size, utilizing 35mm film as a recording medium. The chief advantages of these types of cameras are economy of film, compactness and adaptability to any technique and simplicity of action (figure1).

Figure 1: Miniature camera

- Rangefinder cameras

Rangefinders are so called because the focusing mechanism in such cameras involves the use of an optical rangefinder, a device that measures distance by measuring parallax between images seen from two different points (figure 2).

Figure 2: Rangefinder camera

- Single-lens reflex cameras

Single-lens reflex cameras are so called because both the viewfinder and the film see the world through the same, main photographic lens (figure 3).

Figure 3: Single- lens camera

- Digital cameras

Digital Still cameras are cameras whose primary purpose is to capture a photograph in digital format. Initially, a digital camera was characterized by the use of flash memory and USB or FireWire for storage and transfer of still photographs.

- Compact digital cameras

Also called digicams, this encompasses most digital cameras. They are characterized by great ease in operation and easy focusing; this design allows for limited motion picture capability (figure 4).

Figure 4: Compact digital camera

- Prosumer cameras

Prosumer cameras or extended zoom cameras form a general group of higher end cameras that physically resemble SLR "professional" cameras and share some features, but are still geared towards consumers (figure 5).

Figure 5: Prosumer camera

• Lens [12,13]

A Lens is an optical device through which light is focused in order to form an image inside of a camera either on film or on a digital sensor.

- Classifications

1) First type of classification is -

a. Normal

b. Wide-angle

c. Telephoto

d. Fisheye

2) Second type of classification is –

a. Fixed lens

b. Interchangeable lens

3) Third type of classification is –

a. Prime lens

b. Zoom lens

a. Normal

A normal lens has an angle of view that approximates how the human eye sees a scene. A lens is considered normal when its focal length is approximately equal to the diagonal of the film format (figure 6).

Figure 6: Normal lens

b. Wide-angle Lens

A wide-angle lens is a lens with a focal length shorter than normal. A wide-angle lens, as opposed to a fish-eye, is normally well-

corrected for geometrical distortion, i.e., straight lines appear straight (figure 7).

Figure 7: Wide-angle lens

c. Telephoto Lens

A telephoto lens is any lens with a focal length longer than normal. A telephoto lens brings far subjects closer, like a telescope, hence the name (figure 8).

Figure 8: Telephoto lens

d. Fisheye Lens

Fisheye lenses have the widest field of view of any lens group. The geometrical distortion of the image is purposefully maintained high and straight lines appear curved if they are near the edge of the image (figure 9).

Figure 9: Fisheye lens

a. Fixed Lenses

A fixed lens is simply a lens that is permanently fastened to its camera as opposed to a system camera that allows different lenses to be used on the same camera easily. Fixed lenses are designed for a specific camera model and so fewer compromises have to be made in the lens design (figure 10).

Figure 10: Fixed lens

b. Interchangeable Lenses

Interchangeable lenses are more commonly found on cameras aimed at professionals and enthusiasts including large format, SLR (medium format and 35mm) and high-end rangefinder cameras (figure 11).

Figure 11: Interchangeable Lenses

a. Prime lens

The term prime refers to a lens with a single focal length. Typically, prime lenses have larger maximum apertures, so they are able to let in more light wide open than similar zoom lenses (figure 12).

Figure 12: Prime Lens

b. Zoom lens

A zoom lens is a compound lens with a variable effective focal length. the perspective does not change, shifting the focal length of a zoom lens does allow the photographer to modify the crop of a photo without moving (figure 13).

Figure 13: Zoom lens

Other lenses

Macro lens are intended specifically for photographing subjects at extremely close range (a few centimeters or inches). The design of such lenses is optimized to permit and enhance use at such close range.

Reflex telephoto lenses are lenses of extremely long focal length that incorporate some of the principles of telescope optics.

Aspheric lenses incorporate lens elements with surfaces that do not fit on a sphere (figure 14).

Figure 14: Aspheric lens

Light Unit

Technically, good lighting is essential for the optimal final appearance of the photograph. It is important for the lighting system to be simple, in order to enable reproduction in the same manner at different time intervals, and for it to continue to retain its standard appearance.

❖ Types of flash light [12]

- Hot Lights

Continuous lighting that generates more heat than light. E.g., tungsten (figure 15).

Figure 15: Hot light

- Cool Lights

Continuous lighting that generates more light than heat. E.g., fluorescent light (figure 16).

Figure 16: Cool Light

- Strobes

Non-continuous lighting. E.g., a flash gun, ring flash (figure 17 a,b,c).

Strobe Light

Ring Flash

Ring Flash mounted on Camera

Figure 17a: Strobe light, Figure 17b: Ring light, Figure 17c: Ring Flash mounted on camera.

Most commonly recommended light unit for dental photography is use of Ring Flash.

❖ Advantages of using Ring Flash are

- Uniform distribution of light

- Elimination of shadow

Film [13]

Film is a replaceable strip, sheet or plate, usually made of plastic used for recording of images. It is coated with a blend of chemicals that undergo an invisible reaction when exposed to light (figure 18).

Figure 18: Films

- Film Types

Film can be divided into two broad types

1) Negative film

2) Positive film

Negative film contains an inverted image after development; that is, the image on the film shows dark areas where the original image was bright, and vice versa. Positive film yields a directly-viewable image right on the film; it is used for transparencies (slides) intended for direct projection onto a screen or direct viewing in some sort of slid viewer.

- Development

The images recorded on exposed film are invisible, or latent. They are made visible by immersing the exposed film in a sequential series of chemicals baths, in a process called Development.

Storage Media [14]

Digital cameras do not use film to capture images. Instead pictures are saved on some form of internal storage media or memory cards. Their capacities range from 4Mb to 2Gb and are increasing all the time as technology progresses (figure 19).

Figure 19: Storage media

Mirrors

In orthodontic photography, mirrors are used for occlusal and sometimes buccal views of occlusion.

Types of mirrors (figure 20a,b)

- Glass mirrors

- Stainless steel mirrors with handle.

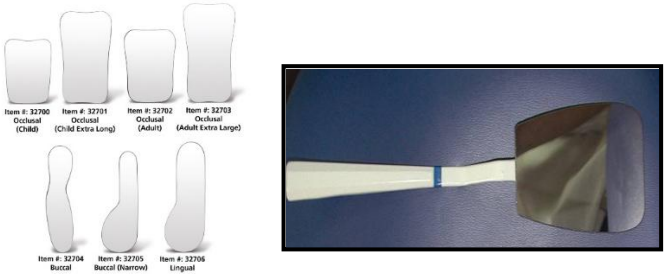

Figure 20a: Glass mirrors Figure,

20b:Stainless steel mirror with handle.

Lip Retractors

Adequate access for intraoral photographs has been limited by the difficulty in management of retraction of lips and cheeks. In order to obtain a good view of teeth in occlusion and also of occlusal surfaces of teeth, it is important to have adequate retraction of lips and cheeks.

According to *Robert E. Binder* [5], a lip retractor, 71/2 cm wide and 12cm long is universal in application. He has mentioned a simple procedure of fabrication of lip retractor from base plate acrylic material for occlusal photography (figure 21).

Figure 21: Retractors

Parameters of Photography [15, 16, 17]

-Bits and Bytes

Digital information is stored in binary code. The smallest unit of binary code is a bit, which is either a 0 or a 1. A byte is composed of 8 bits and is the unit used to measure a file's size (kilobytes, megabytes, and gigabytes). A byte will have 256 possible combinations of zeros (0) and ones (1), 28 = 256 (i.e., 01011011, 10101010, or 11100111). A digital image is composed of small squares called pixels (short for picture element). The computer or printer forms the image by turning pixels off or on or by assigning a color to each pixel. Digital cameras are often advertised as having a mega pixel image (e.g., 1.3 or 3.1 mega pixels). This is derived by multiplying the number of horizontal pixels (dots) times the number of vertical pixels, e.g., 2048 pixels × 1536 pixels = 3,145,728 pixels. The file size of an image is the number of pixels times the number of colors (e.g., 3.1 million pixels × 3 = 9.3 megabytes [MB]).

-Image Resolution

Unlike, conventional photographs where we refer to a 5 x 7-inch or 8 x 10-inch print; the overall size of a digital image is measured in pixels. They are grouped in a matrix of colored dots. The density of this matrix determines the amount of detail the image can show. This is known as resolution.

Pixel dimensions for digicams may range from 2400 x 1800 or higher to resolutions as low as 800 x 600 or even 640 x 480.

-Colors

Each pixel is assigned 1 or more data bits for the pixel's color. An image with a color depth of 1 bit will be only black and white. A4-bit image (4 bits per pixel) will have 24 color combinations or 16 possible colors.

-File Size

The size of a bitmapped image file is determined by the total number of pixels in the image and the number or depth of colors. The number of pixels in an image will be determined by the size, width, and height of the image, and the number of pixels per inch (PPI) or dots per inch (DPI) or simply by the total number of pixels in the image (number of horizontal pixels times the number of vertical pixels).

-Depth of Field

Depth of field (DOF) refers to what is and isn't sharp in a picture. Images with great depth of field have a large zone of sharpness, so that everything from just a few feet in front of the camera to infinity will be sharp. Depth of field at a given focusing distance extends 1/3 in front of the point of focus and 2/3 behind it. The three key factors to depth of field are aperture, lens type or focal length and subject distance.

-Lens type

At any given aperture, a wide-angle lens or the wide-angle setting of a zoom lens yields far more depth of field than telephotos or tele settings.

-Subject distance

The closer your subject is to the camera the less depth of field you get for any given lens type or aperture.

-Image Stabilization

Camera-shake is one of the major reasons for unsharp images. Image stabilization helps to steady the image projected back into the camera by using floating optical elements, which serve to compensate for vibration caused by the user(figure 22a,b).

Figure22a,b: Image Stabalization

-Optical Zoom

Optical zoom lenses on digicams are usually non-interchangeable, which means that you have to choose a camera with a zoom range that suits your sort of photography. Zoom lenses on digicams usually range from 35 to 70mm, which is sometimes called a standard zoom.

-Digital Zoom

The term digital zoom refers to cropping the central part of the frame to make up a new separate image. Digital zoom can be a useful tool when you have reached the limits of the optical zoom or when working with a fixed lens camera.

-Exposure

The amount of light that is captured by the film or CCD sensor is called exposure. The required exposure value (EV) (value given to a single exposure) is determined by the combination of the sensitivity or ISO speed of the film or CCD, the aperture of the lens and the shutter speed used.

-Autofocus

Digicams can be equipped with two kinds of autofocus. Active autofocus cameras emit an infrared beam which is reflected by the subject so the camera can focus on it. Passive autofocus can lock on to your subject when there is light and contrast. Especially vertical lines work well for these systems.

-ISO sensitivity

ISO is the international standard used to denote film speed. It has been carried over to digital imaging and all manufacturers now provide the ISO equivalent for the

sensors they employ in their camera.

Standardization of Photographs

1. Method of Standardization as suggested by *Wolfgang Bengel* [18] – Photographic apparatus.

35 mm Single Lens Reflex Camera.

100 – 135 mm Lens.

Lateral Flash for Extra oral Photographs.

Ring Flash for Intra oral Photographs.

-Intra oral Photography

I. 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

II. 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 sulcus or 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.

III. 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 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.

-Extra Oral Photography

Background – it should be harmonious. Generally grey or white background is suitable

Illumination – photofloods or electronic flash units

Position of Mandible – in rest position with lip in resting state and normal relation.

I. Profile View

Top edge of the frame should be just above the head 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

II. Frontal View

Top edge of the frame should be just above the head and bottom edge in the region of larynx

Focus should be on the patient's eye

Inter pupillary line should be parallel to the top or bottom edge of the frame.

2. Method of Standardization of Intra oral Photographs as suggested by *Hielke Brouwer* and *A. Jan Van Hillegonds-Berg*[19] –

Routine intraoral photography

For standard front and lateral intraoral view 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* [6]

Use of Point source of illumination

Use of Buccal or Occlusal mirrors oriented 450 to occlusion or occlusal surface of teeth and camera oriented 450 to mirror so that resultant image would be at 900 to the occlusion

Area being photographed should occupy same position in frame each time

The orientation of camera to the teeth being photographed should be consistently reproducible.

4. Standardized Extra oral photography by *Lewis Claman et. al*.[7]

Head position

Photograph should encompass – Crown of head to clavicle

Camera to subject distance should be kept constant

Inter pupillary line should be parallel to horizontal plane

Distance from outer canthus to hairline should be equal on each side

Line from outer canthus to superior attachment of ear should be parallel to horizontal plane

For Profile photograph – inner and outer aspect of eye which is on photographic side should be visible

- Camera Lens and position

Focal length of lens should be kept constant (100mm or 105mm)

Line from middle of lens to eye should be parallel to horizontal plane and lens should be centered between two eyes.

- Mandibular position

While taking photograph patient must in relax position and mandible should be at centric relation (not in centric occlusion).

Guidelines for Submitting Images for Publication

Every journal and paper or article publication have their standard parameter of photograph for journal publication-

Following guidelines for submitting images in American journal of Orthodontics and dentofacial Orthopedics given by journal Authors-

• If you are capturing the image on film, just send the black-and-white print or the color transparency; there is no need to scan the figure yourself.

• A digital photo is a bitmap image. Therefore, it should be saved in a bitmap file format, preferably TIFF.

• Although the format is important, an even more critical consideration is the resolution. How many pixels should the image have? The number of pixels is a compromise between image quality on one hand and speed and size concerns on the other. The more pixels an image has, the larger the file will be, and the more time it will take to transmit, load, and

print. A color or grayscale image on a printed page, viewed from the usual reading distance, needs at least 300 dpi to ensure that the pixels are small enough not to be discernible to the human eye. The AJO-DO prefers to receive images that are at least 5-inch-wide, so multiply 5 inches by 300 dpi, and you'll need an image that is 1500 pixels wide (or 300 pixels per inch).

• Always take the photograph at high resolution and save a high-resolution copy. Make an additional, lower-resolution copy of the photo for your own use.

• If you are using conventional photography, AJO-DO prefers to receive your original photographs or transparencies. Their publisher has employees who work full-time to scan and prepare images for publication.

• One can scan the photographs himself, keeping the following rule in mind. Required pixels/original picture size in inches = resolution. If you are scanning a 35- mm slide, remember that the AJO-DO prefers to work with images that are at least 5 in or 1500 pixels wide, so the minimum resolution to scan is 1500 pixels/1.38 in = 1086 dpi. You might have better luck scanning a 3 × 5-in print: 1500 pixels/3 in = 500 dpi.[15,20,21,22]

Uses of Photography as Related to Orthodontics

Uses of photography are broadly divided into

- Diagnosis
- Evaluation of changes between Pre and Post treatment views
- Motivation of patient
- Medico-legal purpose

-Diagnosis

Extra oral photographs can be used for diagnosis and treatment planning.

-Evaluation of changes between Pre and Post Treatment Views

Both intra oral and extra oral photographs are useful for evaluating the post treatment changes. This is helpful to the orthodontist in many ways:

Extra oral views show changes in profile, smile, nasolabial angle, lip competency etc. Intra oral views show changes in occlusion, individual tooth position changes, arch form etc.

-Motivation of patient

Motivation of the patient is one of the important aspects of orthodontics. By showing the pre-treatment and post treatment photographs of previously treated cases or mid treatment photographs of the same patient, an orthodontist can motivate patients and gain co-operation from the patient.

-Medico-legal purpose

As there is increasing awareness in the patient regarding the laws, it is important to keep records of all patients for medico-legal purpose. Photographs and also plaster models serve as best proof for medico-legal purposes the Consumer Protection Act 1987 states that it is necessary to retain all patient records for not less than 11 years and the British Association of Orthodontists recommends that study models should be kept for 11 years or until the patient is 26 years old.[23]

Various Extra-oral and Intra-oral views and Their Sequence [24]

Extra oral Views

-Frontal view

Camera should be positioned in front of patient's head – on the same level as the patient.

There should not be any tilt in the camera position

Distance of patient from camera about 180cm

Mandible of the patient must be in resting position

Two photographs must be taken in frontal view

Lips in relaxed state (figure 23).

Figure 23: Frontal view natural smile

-Profile view

Camera and head orientation are same as for frontal view

Eyebrow on the side of photograph should be visible only and not the opposite side eyebrow

Focus should be at patient's eye

Lips should be in resting state (figure 24)

Figure 24: Profile view

-Intra-oral views

Frontal intra oral view

It is taken in centric occlusion

Lip retractors are used for retraction of lips. Lips should be retracted as well as pulled away in front from teeth.

Occlusal plane should be parallel to top or bottom edge of frame (figure 25).

Figure 25: Frontal intra oral view

- Buccal view

It is also taken in centric occlusion

Occlusal plane should be parallel to top or bottom edge of frame

If possible, last erupted molars should be included in the frame (figure 26 a,b)

Figure 26 a: Buccal view left side

Figure 26 b: Buccal view left side

- Occlusal views

Maxilla and mandibular occlusal views are taken using mirrors

Mirrors should be pre-warmed to avoid fogging

Inter molar line should be parallel to top or bottom edge of the frame (figure 27a,b).

Figure 27a: Maxillary Arch Occlusal View

Figure 27b: Mandibular Arch Occlusal View

Common Errors in Clinical Photography and Their Troubleshooting

There are a number of errors that are commonly seen and these can be divided into two groups. The first group comprises errors due to inappropriate choice or use of equipment. The second group of errors relates to any recording medium and involves inappropriate positioning of the subjects.

- Technical errors

-Camera

The correct equipment is required for high quality clinical photographs, which include a camera (either conventional or digital) with a macro-facility (ability to produce 1:1 images) and, ideally, a ring flash, an appropriate background, suitable lighting and well-trained assistants. Correct camera orientation is important, with extra-oral photographs taken in portrait mode and intra-oral photographs taken in landscape mode.

- Lenses Pitfalls

When using a telephoto, you should realize that depth of field is very shallow at wide apertures. Focusing therefore becomes very critical if you want your subject to appear sharp in the picture.

- Barrel distortion and Pincushion effect

Correction is performed by shifting each pixel radially. The amount of which is calculated by using a polynomial function based on the specifications of the particular lens used.

- Lighting Pit falls

Most in-camera flashlights lack the power to light subjects more than 3 to 4 meters away, so in these situations a more powerful off-camera flash unit should be used. These provide the right amount of light automatically and adjust power settings according to the aperture used.

- Retractors

Two sizes of double-ended retractor are prerequisite to obtaining a set of high quality intra-oral photographs. The large ends of the larger retractor are used to obtain retraction for the anterior intra-oral shot.

- Mirrors

When rear silvered glass is used there is formation of ghost image in the photograph. Long-handled, front-silvered, glass mirrors are the ideal tool for clinical photography, although they are significantly more expensive than rear-silvered or metal mirrors.

- Positioning errors

Both the patient and the clinician need to be positioned correctly, in a standardized manner, to produce consistent photographs. All features of the malocclusion should be demonstrated, and areas of interest not obscured by clothing, hair, impression material, retractors or saliva.

2. - Photography noise

Image noise is random variation of brightness or colour information in images, and is usually an aspect of electronic noise. It can be produced by the image sensor and circuitry of a scanner or digital camera.

- Noise reduction

An image is a picture, photograph or any other form of 2D representation of any scene. Most algorithms for converting image sensor data to an image, whether in-camera or on a computer, involve some form of noise reduction. This leads to a breakdown of image quality at higher sensitivities in two ways: noise levels increase and fine detail is smoothed out by the more aggressive noise reduction. In cases of extreme noise, such as astronomical images of very distant objects, it is not so much a matter of noise reduction as of extracting a little information buried in a lot of noise; techniques are different, seeking small regularities in massively random data. [25,26,27]

SUMMARY

Photographs of a patient's face provide an enormous amount of information for to guide diagnosis and treatment planning, as well as to document preoperative and post treatment conditions. As patients do not understand their own cephalogram, and neither do they know how to interpret the cephalometric analysis, the photograph represents a much more conventional documentation of the soft tissues and also a visual reference for monitoring the changes which occur during growth and

development. It is a reliable source for qualitative evaluation of postoperative results, as the patient is enabled a review of his own changes prior to and after certain operations, and the therapist can use it as visual material in teaching or as the basis for further research. There is an increasing need for such photo-documentation in orthodontics, as in many other dental disciplines. The prospect of having a camera that can take advantage of computer technology and produce an infinite number of high quality images with little to no additional cost is truly exciting.

CONCLUSION

Photograph provides considerable data for diagnosis and treatment planning of the patients and also digitalization has achieved a new level for photography. Storage and communication of data today is quite a simple process. Photographs can be qualitative evaluation of postoperative results, and the patient can see his/her own changes before and after the treatment, this can help in patient education. A good understanding can help a clinician to a far greater extent than he can imagine.

Digital photography assumes importance for diagnostic and treatment planning procedures as it is low cost and less technique sensitive when compared to cephalometry. Though photography cannot be an alternative for cephalometry in orthodontic diagnosis, the paradigm shift towards soft tissue has elevated the status of photography in treatment planning.

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