

PART 1

Standardization for Dental Photography

Irfan Ahmad, BDS

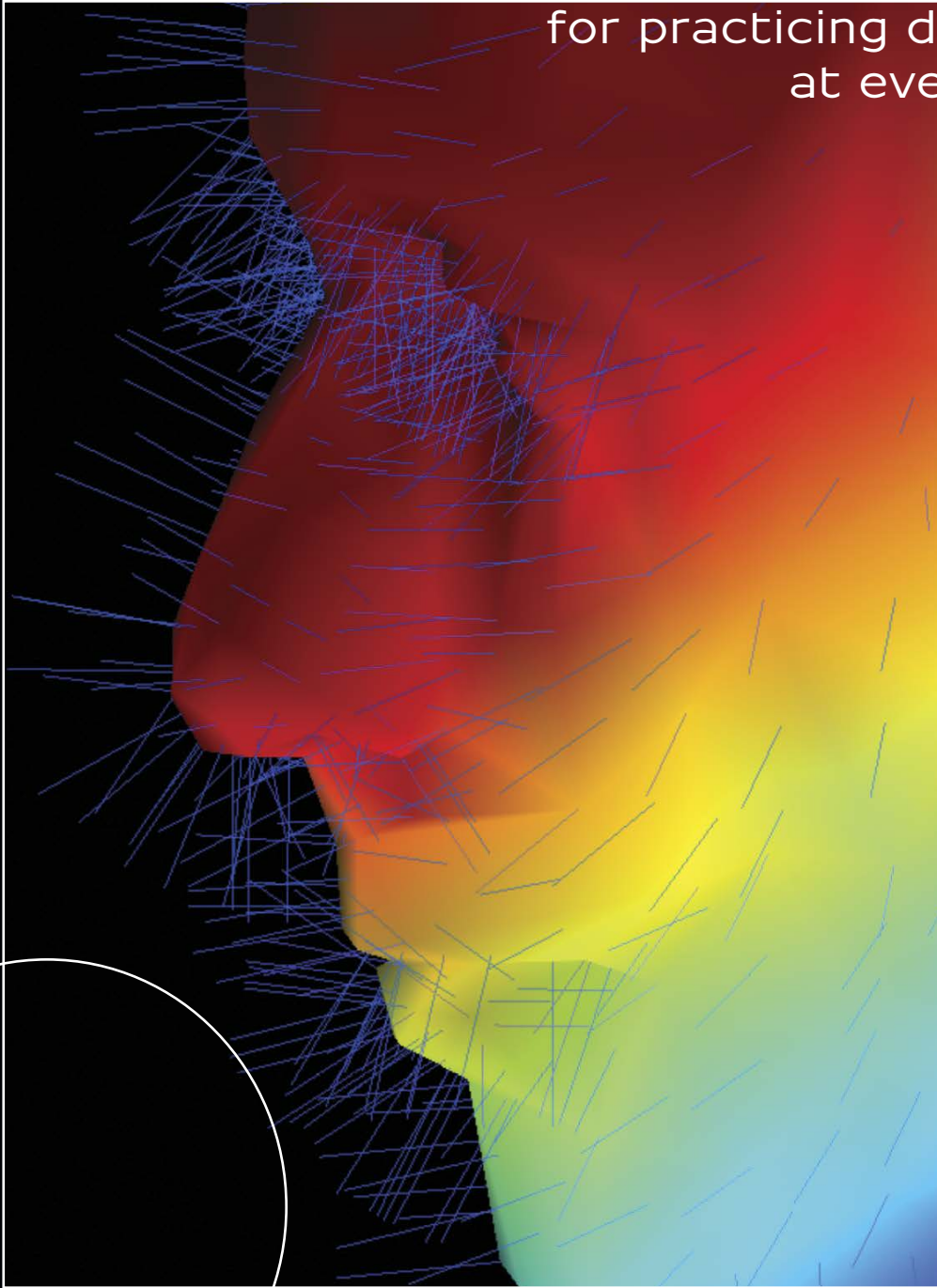
Abstract

Photography has become an essential tool in dentistry. Photo documentation is powerful for clinical communication and self-development. It is useful in every clinical step of a case and for patient records. The learning curve regarding equipment and how to standardize the protocol into a simple procedure can be challenging. The first part of this two-part article discusses the rationale for standardization and its benefits. Emphasis is placed on both clinical and nonclinical images as being equally important for fulfilling different intended purposes.

Key Words: dental photo documentation, protocols for photo standardization, standardizable factors, nonstandardizable factors

“ Today, dental photography is no longer an option, but rather an essential tool for practicing dentistry at every level.

”



Introduction

Technological advances in digital photography have allowed even the novice to take photographs of exquisite beauty, with colors so vivid and nuances so tantalizing as to be comparable to great works of art. What was once reserved for the few, is now possible for the many.

Today, dental photography is no longer an option, but rather an essential tool for practicing dentistry at every level. Furthermore, no matter how meticulously one documents clinical notes of an examination, a photograph will communicate the clinical scenario in just a few seconds. Therefore, it is surprising that this subject is not part of the undergraduate dental curriculum. In addition to offering indisputable visual documentation, photographs are probably the most powerful learning method for clinical dentistry and self-development. A series of images allow assessment, diagnosis, planning, delivery of treatment, and follow-up that no other medium can offer. Furthermore, photography is a vital communication tool among patients, colleagues, specialists, and technicians for discussing multidisciplinary and complex therapies. Preoperative, procedural, and postoperative images provide an invaluable record if a particular therapy fails to deliver the desired results or meet a patient's expectations.

However, many clinicians are hesitant to incorporate photography into their daily practice due to uncertainty about the choice of equipment, a steep learning curve, and initial capital expenditure. These notions are fueled by the plethora of dental literature on the subject, some scientifically based, some anecdotal, while others just complicate what is basically a simple process. The goal of this article is to demystify many of these erroneous beliefs by proposing protocols for standardizing photographs that are invaluable for intra- and interpatient comparison. Once the essentials are mastered, a little experimentation will allow the operator to develop his or her own style and progress to the next level by modifying techniques for specific disciplines.

The two articles in this series propose principles for standardization in dental photography. Part I discusses the rationale for standardization, why it is necessary, and how it benefits the delivery of dental care, as well as the factors that can be standardized and those that cannot. The equal importance of clinical and nonclinical images (for different intended purposes) is discussed.



Figure 1: Photography is a synesthetic experience.

Every Picture Tells a Story

Photography is a synesthetic experience,¹ similar to the esthetic appreciation of beauty (Fig 1). As with other art forms, a photograph's *raison d'être* is to convey a message and elicit a psychological response.

All images are representations of objects or subjects photographed in a particular light at a given moment in time. If the light is changed, the object or subject appears different, conveying a different message. Dental photography is no exception.

Knowing the intended purpose of a photograph, whether conveying clinical information or evoking an emotional response, is essential for determining the type of imagery required. Images for communicating with colleagues convey a different message than those for eliciting reactions from patients. The latter are subliminal sales pitches, critical for successful advertising.² However, such photographs are not useful in conveying clinical reality to arrive at a diagnosis or subsequent treatment planning. For this, unbiased images are necessary.³ Standardized imagery is ideal for consistency and comparison.

Both the dental literature and the internet are replete with imagery that crosses the clinical/artistic line. However, there is room for both styles (Figs 2 & 3). Producing artistic photographs depends on the creativity of the photographer rather than on the type of camera or other photographic equipment. This aspect of photography is difficult (or even impossible) to teach; artistic skill develops with passion and time. This article addresses techniques to produce predictable and repeatable clinical results.

What Determines Standardization?

Dental photography is basically visual dental documentation; its value lies in comparison for critique of cases, and historical cohort studies for monitoring as well as research.⁴⁻⁶



Figure 2: Image with high marketing value but low clinical value.



Figure 3: Image with high clinical value but low marketing value.

To realize these objectives, it is necessary to have some form of standardization to establish guidelines for consistency, comparison, and communication.^{7,8} This standardization must begin when an image is composed and captured and end when it is processed/displayed via editing with computer software and reproduced with the chosen media (monitor, projector, print). There are three aspects to be standardized: human factors, technical factors, and the image's intended use.

Human Factors

The human factors are the patient, assistant, and the operator, usually the clinician, who takes the photographs while the assistant ensures patient comfort and helps with positioning the dental and photographic equipment. Operator factors include sufficient knowledge, training and experience in dental photography, and the ability to adapt to patients' idiosyncrasies to avoid jeopardizing the photographic session. Patient factors include his or her physical and emotional condition, and whether they are able to fully cooperate with the photographic procedures. This could mean controlling excessive salivary flow or taming involuntary gagging reflexes. In addition, it is necessary to pay attention to any local soft and hard tissue anatomical variations that may hinder posture in the horizontal, vertical, and sagittal planes. Another issue is obtaining an unimpeded retraction of the extraoral soft tissues for a clear field of view (FOV) of the oral cavity.

Technical Factors

The basic technical requirements of an image are that it be sharp, in focus, correctly composed with the proper color balance and exposure, and accurately record the subject. This requires an understanding of fundamental photography concepts and ability to configure the camera and ancillary equipment settings to produce repeatable and predictable results. Technical aspects include variables such as the dental armamentarium, camera sensor size, the lens focal length and axis or angle of view (vertical and horizontal composition), equipment settings, illumination (quality and quantity), background, and scaling or magnification.

Intended Use

The intended use may be clinical documentation, marketing, or educational. Clinical documentation also depends on the particular specialty. A portfolio of stock views is adequate for basic documentation, but additional images are required depending on the specialty, or a specific treatment modality. For example, a standard set of extra- and intraoral images is sufficient for cranio-maxillo-facial surgery⁵ but inadequate for a ceramist who is fabricating a single-unit crown to match an adjacent natural tooth. Marketing images promote a given treatment and omit graphic depictions of surgical procedures. Recording treatment sequences and outcomes for educational purposes (e.g., lecturing and publishing) is also aimed at a target audience; these im-

ages are different from straightforward clinical documentation, and incorporate aspirational aspects to enhance the teaching and learning process.

Achieving Standardization

Certain aspects of dental photography can be standardized. These include predefined positions of the patient, photographic equipment, and operator; and configuring photographic and ancillary equipment to specific settings. However, some factors, predominantly hardware-related, cannot be standardized. These include equipment unique to a particular manufacturer that is not interchangeable or compatible with other brands. There are innumerable competitors with proprietary “closed” systems; this offers great consumer choice but at the expense of forgoing generic open systems. Therefore, the factors that are standardizable will produce comparable and consistent images for intra- and interpatient documentation, but are limited to an individual dental practice or institution with specific brands of photographic equipment.

Standardizable Factors

Standardizable factors relate to photography equipment settings, patient positioning,⁹ dental armamentarium, and the operator. Ideally, a set of dental photographic protocols should

be established and followed for achieving direct comparisons, even if the photographs are taken by different operators.

The technical elements for standardization are the equipment settings for consistent exposure,¹⁰ depth of field (DOF), composition, framing, orientation, color rendition, file formats, elimination of extraneous artefacts, and the requisite number of images for a given portfolio. The correct exposure can be achieved by either using flash through-the-lens (TTL) metering or taking a few test images for identical setups. Another essential factor is precise color rendering, without unwanted color casts, for distinguishing healthy and diseased tissues. This is accomplished by having the correct white balance (WB) (Fig 4), periodically adjusting computer displays with calibration devices, and maintaining the same International Color Consortium (ICC) color profile for all images. Although resolution cannot be standardized due to unique hardware specifications, this is not an overwhelming concern since most contemporary cameras can deliver adequate resolution for the majority of dental applications. Nevertheless, a dental image should have sufficient detail for discerning salient features of hard and soft tissues. However, different specialties, or images for special applications, may require specific visual information that necessitates a higher degree of resolution. Finally, images in a standard portfolio should convey the following features with clarity and clinical fidelity¹¹ (Figs 5-7):



Figure 4: Image showing different color rendering by altering the camera’s WB setting (AWB = automatic white balance). The ideal WB for dental photography is photographic daylight at 5500K.



Figures 5-7: Clinical images showing clearly recorded features that have diagnostic value.

- Distinction between healthy and diseased tissue, especially to detect pathological changes.
- Attached gingivae, showing degree of stippling for assessing periodontal biotypes (thick, thin) and bioforms (scalloped, flat).
- Transition between keratinized and nonkeratinized oral mucosa for assessing width of keratinized tissue (attached gingivae, free gingival margin, gingival groves, clefts, scarring).
- Shade transition in teeth traversing from cervical to body to incisal edges.
- Enamel characterizations, lobes, mottling, stains, chips, texture, hypoplasia, cracks, fractures, and perikymata.
- Incisal, interproximal translucency, and mamelons.
- Attrition, abrasion, erosion, and abfraction lesions.
- Hypocalcification, fluorosis, and tetracycline staining.
- Cervical dentin exposure, extrinsic, intrinsic, and internalized pigmentation.
- Defective restorative margins.
- Secondary caries, restorative material wear, chips, and discoloration.

Scaling or magnification is another aspect crucial to ensuring consistency.¹² The usual magnification for dental photographs (1:1 or 1:2 for intraoral views, 1:5 for dentofacial compositions, and 1:8 to 1:15 for full-face or portrait images) is based on 35-mm film photography. All analog 35-mm cameras use the same celluloid film comprising identical 35-mm × 24-mm frames. Hence, for a given focal length lens, the magnification factor is always the same for these cameras, regardless of the brand. However, this is not the case with digital photography, since the film is replaced by sensors that have different physical dimensions (Fig 8). Therefore, the magnification factor of a lens is applicable only for cameras that have a full-frame sensor corresponding to the size of a 35-mm film frame (Fig 9). If the sensor is smaller (as is usual) or larger than conventional 35-mm film, a crop factor is applied, which varies according to the sensor's size. To overcome the issue of different sensor sizes and to ensure a con-

“ ..photographs are probably the most powerful learning method for clinical dentistry and self-development.”

sistent magnification, the focusing distance on the lens barrel can be preset for a particular view (e.g., intraoral, dentofacial, or portrait compositions).

In addition to the technical issues of scaling, the physical size of facial features and intraoral anatomy varies enormously among individuals. If the maxillary and mandibular arches are large or small, a preset magnification may crop vital features, or include extraneous objects such as cheek retractors, respectively. Another approach for ensuring a consistent FOV with both extraoral and intraoral images is the use of anatomical landmarks. For clinical portraiture, instead of using a predefined magnification, the background area surrounding the hairline and the auricles can be predefined with the lower margin bounded by the sternoclavicular joint. For dentofacial views, the landmarks could be the tip of the chin (menton) to the middle of the nose (rhinion) (Fig 10). For intraoral images, the mucogingival junction, retracted sulci, number of posterior teeth, and buccal corridor are helpful anatomical reference points for ensuring reproducible and consistent compositions, irrespective of the magnification scale. To convey scale within an image it is useful to include markers such as periodontal probes or rulers for indicating dimensions of teeth, restorations, soft tissue landmarks, or pathological lesions (Fig 11). The major factors that can be standardized are summarized in Table 1.

COVER FEATURE

Lens image circle matching a full frame sensor

Lens image circle matching a full frame sensor

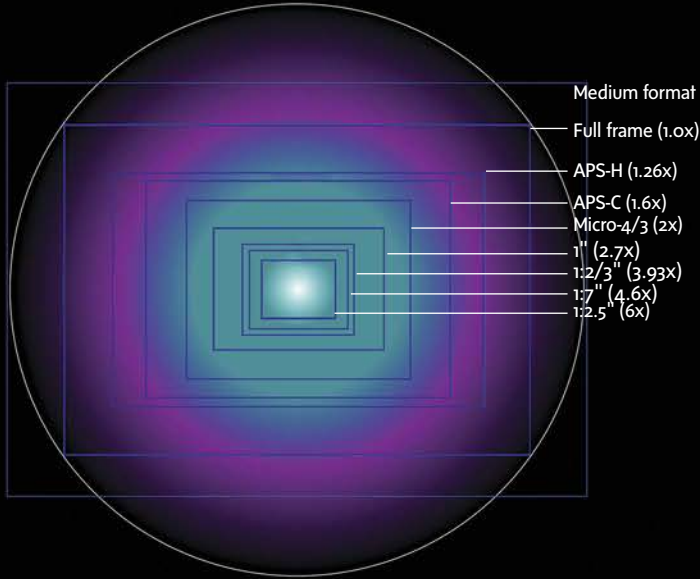


Figure 8: Comparison of digital camera sensor sizes with the corresponding crop factor in parentheses.

Figure 9: A full-frame sensor has the same magnification factor as the focal length of the lens (crop factor 1.0x).

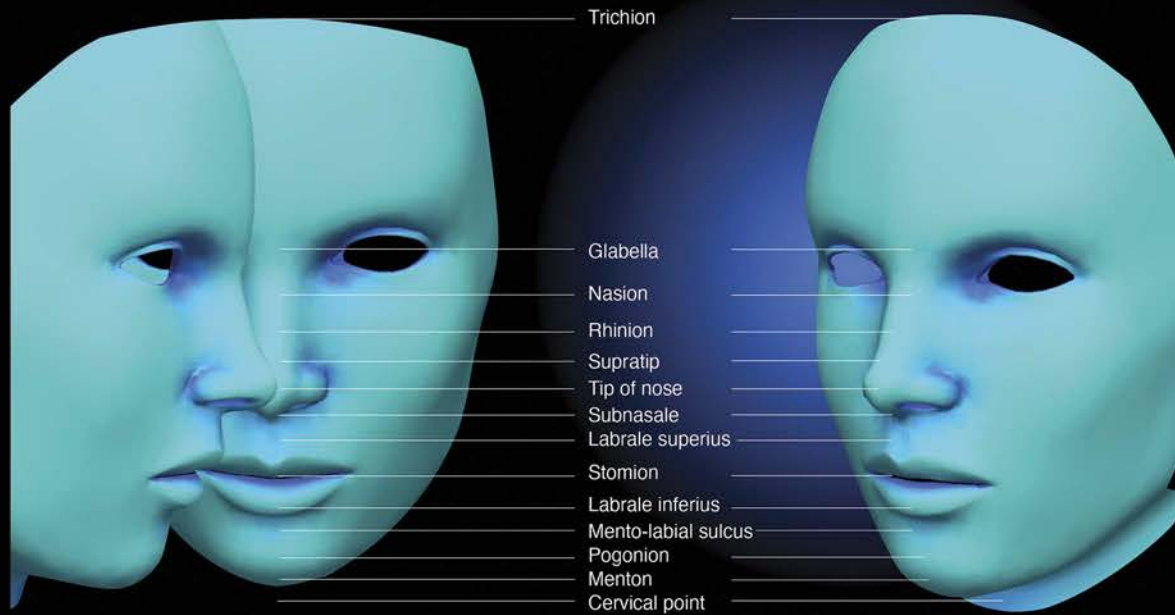


Figure 10: Facial anatomical landmarks are useful guides for framing a particular view.



Figure 11: Markers such as periodontal probes are an ideal way to depict scale within an image.

Table 1. Standardizable Factors for Dental Photography

WHAT	WHY	HOW
Positioning (patient, operator, assistant, equipment)	To expedite photographic session, repeatable images for diagnosis, treatment planning, sequencing outcome, and intra- and interpatient comparisons.	Patient position: seated upright, partially reclined or supine (depending on the type of image required). Mount camera on tripod, mark floor for positions of camera, lights, photographer, and assistant.
Image orientation	For same perspective.	Landscape orientation.
Spatial orientation	For same angle of view in vertical, horizontal, and sagittal planes.	Use orientation guides such as the horizon, Frankfort plane, Camper’s line, interpupillary line, facial midline (Fig 12), camera viewing screen grids, spirit level.
Composition (FOV)	For consistent views.	Magnification factor, preset focusing distance on lens, intraoral, and extraoral anatomical landmarks.
Framing	To crop irrelevant parts of image so as to concentrate on points of interest.	Capture image with larger framing for subsequent cropping in imaging software.
Exposure	For faithfully reproducing subjects with a given lighting setup.	For intraoral images: manipulating intensity and distance of flashes. For extraoral images: manipulating shutter speed, f-stop, ISO, histogram, and illumination (intensity and distance).
Color rendition	For true color reproduction.	Setting the WB; identical ICC profiles.
Sharpness	For discerning details.	Fast shutter speeds, flash illumination, ideal hyperfocal distance, sufficient DOF.
Extraneous objects	For avoiding visual distractions.	Judicious placement of saliva ejector, cotton wool rolls, edges of mirrors, cheek retractors and contrasters. Remove saliva, blood, biofilm, extrinsic stains, food debris. Prevent scratches, droplets, fogging (condensation) on mirrors.
Number of images in portfolio	For interpatient comparison, and comparing pre- and postoperative treatment outcomes.	Predefining the number of images according to the dental discipline or specific application.
Post-capture processing	To provide consistent criteria for comparisons.	Use same photo-editing software for exposure correction, orientation, cropping extraneous artefacts or parts of image.
Metadata	For recall and archival.	Date, patient details, camera, and software settings.
Image data format (file format)	To enable different formats for different needs.	Small JPEG files for internet communication, large TIFF files for publishing and archiving.

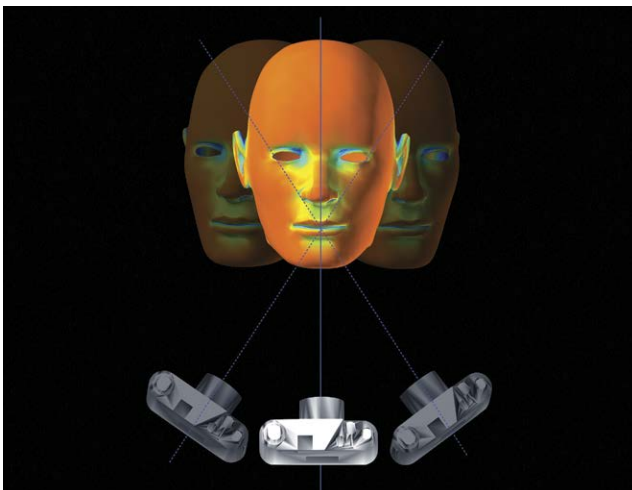


Figure 12: The facial reference points are useful guides for orienting the head in the horizontal and vertical planes.

“ Images for communicating with colleagues convey a different message than those for eliciting reactions from patients. ”

Key Takeaways

- No matter how meticulous the written or oral clinical notes of an examination, a photograph will communicate the clinical scenario in just a few seconds.
- The intended purpose of a photograph is critical for determining the type of imagery required.
- Standardized images are essential for comparison, communication with patients and colleagues, and for enhancing the delivery of dental care.

Nonstandardizable Factors

Although not an exhaustive list, the standardizable factors outlined above are sufficient to allow comparisons for the majority of intra- and interpatient photographic documentation. However, there are several factors, mainly hardware-related, that are impossible to standardize. Resolution, color space, bit depth, absolute color rendition, quality and quantity of illumination are all device-specific, with little standardization between different brands. It is worth noting that although the relative color rendition for a given computer display can be standardized using color calibration devices and ICC profiles, absolute color rendition between different monitors presents a challenge. Images today are disseminated rapidly through the internet and viewed on innumerable mobile devices such as smartphones, tablets, or smart televisions. The color space for all these displays is unique, and therefore an image will have a different color rendition, which is virtually impossible to standardize. A simple method for circumventing different color rendition on display devices is to include a reference picture taken with a neutral-density gray card when transmitting a particular portfolio. The reference image can then be used by the recipient to calibrate all images within a portfolio to ensure correct color rendition.

In addition, post-capture image processing by in-camera processors and various imaging software yields disparate results depending on their unique algorithms.¹³ Lastly, human fallibility also plays a part in standardizing (i.e., patient and opera-

tor factors). Children, the elderly, and patients with limited mouth opening or debilitating illness may be unable to tolerate, or fully participate in, a lengthy photographic session. This includes maintaining a particular position or tolerating cheek retractors and other intraoral dental armamentarium for correct image framing and composition.

The last aspect of standardization is integrity.¹⁴ Current photo-editing software allows even a computer novice to transform the proverbial “girl next door” into a Mona Lisa. While tampering of this nature is enjoyable and harmless in hobbyist photography, deliberately manipulating clinical documentation (e.g., concealing preoperative pathology or enhancing postoperative treatment results by camouflaging defects) is unethical at best.¹⁵ In addition, altering images for publishing or lecturing for personal advancement is obviously deceitful. Photographs are essentially visual dental documentation, no different than dental records or radiographs. Therefore, strict adherence to medical ethics is paramount.

Summary

The first part of this two-part article has defined standardization and its rationale for dental photography. The importance of standardization for comparison, as well as for monitoring and evaluating treatment outcomes, was highlighted. Part II will present two portfolios—the essential dental portfolio and the essential portrait portfolio—for photo documentation with detailed guidelines for achieving these standardized intraoral and extraoral images in clinical practice. These two portfolios are appropriate for most dental disciplines and are an ideal starting point for communication with patients as well as colleagues.

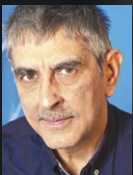
Editor’s Note: This article is adapted from the author’s book *Essentials of Dental Photography* (Wiley; Oxford, UK, 2019).

“

Once the essentials are mastered, a little experimentation will allow the operator to develop his or her own style and progress to the next level by modifying techniques for specific disciplines.”

References

1. Cytowic R. The man who tasted shapes. Cambridge (MA): MIT Press; 2003.
2. Key WB. Subliminal seduction: ad media's manipulation of a not so innocent America. Upper Saddle River (NJ): Prentice-Hall; 1973.
3. Manjunath SG, Ragavendra RT, Sowmya KS, Jayalakshmi K. Photography in clinical dentistry - a review. *Int J Dent Clin*. 2011;3(2):40-3.
4. Bengal W. Standardization in dental photography. *Int Dent J*. 1985 Sep;35(3):210-7.
5. Ettorre G, Weber M, Schaaf H, Lowry JC, Mommaerts MY, Howaldt HP. Standards for digital photography in cranio-maxillo-facial surgery—part I: basic views and guidelines. *J Craniomaxillofac. Surg*. 2006 Mar;34(2):65-73.
6. Galdino GM, Vogel JE, Vander Kolk CA. Standardizing digital photography: it's not all in the eye of the beholder. *Plast Reconstr Surg*. 2001 Oct;108(5):1334-44.
7. Graber TM. Patient photography in orthodontics. *Angle Orthod*. 1946 Jan;16(1):17-43.
8. Martins RFM, Costa LA, Bringel ACC, Pereira ALP. Protocol for digital photography in orthodontics. *Rev Clin Orthod Dent Press*. 2013;12(4):102-11.
9. Sommer DD, Mendelsohn M. Pitfalls of nonstandardized photography in facial plastic surgery patients. *Plast Reconstr Surg*. 2004 Jul;114(1):10-4.
10. Niamtu J. Image is everything: pearls and pitfalls of digital photography and PowerPoint presentations for the cosmetic surgeon. *Dermatol Surg*. 2004 Jan;30(1):81-91.
11. Ahmad I. Digital dental photography. Part 1: an overview. *Br Dent J*. 2009 Apr;206(8):403-7.
12. Sugawara Y, Saito K, Futaki M, Naruse M, Ono M, Hino R, Chiba Y, Arakaki M, Yamada A, Fukumoto S. Evaluation of the optimal exposure settings for occlusal photography with digital cameras. *Pediatr Dent J*. 2014 Aug;24(2):89-96.
13. Bister D, Mordarai F, Aveling RM. Comparison of 10 digital SLR cameras for orthodontic photography. *J Orthod*. 2006 Sep;33(3):223-30.
14. Schaff H, Streckbein P, Ettorre G, Lowry JC, Mommaerts MY, Howaldt HP. Standards for digital photography in cranio-maxillo-facial surgery—part II: additional picture sets and avoiding common mistakes. *J Craniomaxillofac Surg*. 2006 Oct;34(7):444-55.
15. Chowdhry A. Seeing is no longer believing [letter]. *Indian J Dent Educ*. 2016 Apr-Jun;9(2):139. **jCD**



Dr. Ahmad is in private practice in Harrow, United Kingdom. He is a Consultant Prosthodontist at Imam Abdulrahman Bin Faisal University, in Damman, Saudi Arabia.

Disclosure: The author did not report any disclosures.