



## Assessment of Image Quality and Child Acceptance for DSLR, Bridge and Smartphone Cameras Used in Dental Photography (A Comparative Study)

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### Keywords:

Digital, Photography, Lens, Camera, Macro

### Article Info.:

#### Article History:

Received: 27/7/2023

Received in revised form: 13/8/2023.

Accepted: 4/9/2023

Final Proofreading: 4/9/2023

Available Online: 1/6/2024

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**Citation:** Mohamed SF, Jasim AA, Muhsen SJ. Assessment of Image Quality and Child Acceptance for DSLR, Bridge and Smartphone Cameras Used in Dental Photography (A Comparative Study). *Tikrit Journal for Dental Sciences* 2024; 12(1): 58-68

<https://doi.org/10.25130/tjds.12.1.6>

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### Abstract

Digital photography is of huge importance during the course of dental treatments. It's indispensable for recording data, patient motivation, communication with the lab etc. Many photography equipment are available and used in dentistry. Using digital photography is obtaining a footstep in pediatric dentistry. The purpose of this study is to evaluate the quality of dental images made by different digital photography mediums commonly used in dental clinics and measure the acceptance of children towards dental photography.

**Materials and Methods:** in this study images produced by Three DSLR (digital single lens reflex) cameras along their prober lenses, one bridge camera and two smartphones with different sensor sizes were evaluated, based upon the sharpness, quality, color fidelity, and general context of the photographs. The participants were divided into three main groups: under-graduate students; graduated dentists and graduated dentists with photography experience. 20 pediatric patients were imaged using the aforementioned equipment. **Results:** DSLRs with macro lenses and ring flashes scored the highest means with statistically significant differences ( $p < 0.05$ ). From 20 pediatric patient photographed by each equipment used in this study 18 child accepted smartphone photography

**Conclusion:** Older DSLRS are still usable for dental photography. Kit lenses or extension tubes with camera built in flashes are not appropriate for dental photography. Bridge cameras and smartphones are not adequate for dental photography.

## Introduction:

Obtaining digital images is an immense aid throughout dental treatments particularly for recording patient details communicated between specialists and dental laboratory patient motivation promotion and assessment of the outcomes. In addition, they are essential for identifying facial configuration alterations frequently used in orthodontic, surgery, oral rehabilitation, and digital smile planning <sup>(1-3)</sup>. There are several models available, from humble compact devices, to full-bodied complex models. The foremost prerequisite is an essential acquaintance of photography: light control, diaphragm Aperture, shutter speed, and sensor sensitivity <sup>(4)</sup>. Compact models, which comprise smartphones, generally have few modifiable traits, and are simple to operate and the camera body and lens are contained in a solitary component. The lens also has fixed focal length, between 29 and 33 mm, determined by the manufacturer, more advanced models, also known as bridge cameras, have features similar to DSLRs, like camera mode selector, a more sophisticated non changeable lens, with greater focal length, which might reach up to 3000 mm, a larger sensor, but still much more smaller than that in DSLRs of roughly 1" (13.2 x 8.8mm) <sup>(5-6)</sup>. Low focal lengths are specified for wide-angle photographs (panoramic views), since their wide range. When these lenses are used for close-up images, they produce distortions and achromatic aberrations in the image <sup>(7)</sup>. Besides, compact models do not allow the use of external Speedlight, only built-in or pop-up Speedlight's. Once fired inaccurately, these sorts of Speedlight's can cast shadows in the oral cavity <sup>(4)</sup>.

## Components

Digital single lens reflex (DSLR) **Fig. (1)** Cameras constructed with a robust structure. They have a varied assortment of modifiable tasks and utilities, and the camera body are separate units from the lens mounted on it throughout the lens

mount which has electronic components to control lens diaphragm, lens focal length and focusing lens components to get sharp images. Therefore, the lens can be altered reliant on what the circumstances need. The camera body comprises of a viewfinder, digital sensor, trigger, and shutter button, and normally contains a built in speed lite, amongst other components. The lenses transmit and focus the light reflected from objects to hit the sensor within the camera body. After framing the proper image, observed through the mirror reflecting the light to the viewfinder. This mirror is reflected when the shutter button is pressed exposing the sensor to catch the light producing images. All these functions are controlled with a microchip incorporated within a motherboard placed inside the camera body. <sup>(8)</sup> Macro lenses normally used for dental photographs, as they allow focusing on small objects with high quality detail reproduction. These lenses are with variable focal lengths but most commonly used lengths are between 85 to 105 mm, to provide suitable working distance between dentist and the patient. The 60 mm is used only by orthodontists. These lenses are prime lenses meaning that they are of fixed focal lengths and with f stops between 2.8 to 22 sometimes 32. <sup>(8,9)</sup>. An assessment of images acquired with several gadgets should benefit dentists in selecting the suitable gear. There is a lack in the literature regarding the production of digital images in pediatric dentistry. Some technical difficulties in obtaining the image, such as reduced size of the oral cavity, behavioral aspects and clinical time are important features that may compromise the image quality as well as the clinical procedure. The perfect photograph in pediatric dentistry could be difficult, because repetitions can compromise the management of the child patient. Hence, the objectives of this study were to compare the quality of dental photographs acquired with six dissimilar photographic cameras, assessed by three groups of participants: undergraduate students, dentists, and dentists with photography experience and to evaluate the acceptance

of the pediatric patients regarding the dental photography.

## Material and Methods:

Three DSLR cameras along with their proper lenses, one bridge camera and three smartphones with different sensor sizes were compared in this study through images produced by these equipment. The images were divided into two main groups' clinical documentation images and small dental objects. The clinical documentation images were subdivided into face and oral cavity images **Table (1)** describe the cameras, the lenses and smartphone that were used in this study along with their brands, sensor type. The images were made in the same room under the same lighting conditions to ensure standardization. A tripod and patient to camera distance set to 1.5 meter was used for the face images The DSLR cameras bridge camera and smartphones were hand held with a distance of 50 cm for oral cavity and small objects images using high shutter speed to compensate for any vibration resulting from hand holding the equipment. The setting for Each DSLR camera used in this study (Nikon D7100, Nikon D40, and Nikon D3200) was as follows cameras were in the manual mode with the ISO of 100 aperture of f/8 and magnification ratio of 1/10 for face images and f/22 with magnification ratio of 1/2 for oral cavity images and small object images and the Shutter speed of 1/200 second. As a source of illumination the DSLR cameras built in Flash was used set to manual mode with ¼ of its full power. Also Meike ring flash was used with all of the three DSLR cameras set to fire in the manual mode with 1 / 4 of its full power. During the imaging procedure Each DSLR camera was paired with the 50mm lens with extension tube then replaced by 18-55mm lens, followed by Nikon 105 mm macro lens and finally the Tamron 90 mm macro lens. One bridge camera was used in this study which was the Fujifilm FinePix S4800. The setting of the bridge camera was as follows: macro mode ISO set to automatic with pop up flash on.

Three smartphones were used in the study LG V20, Samsung Galaxy Note 5 and Apple iPhone 8 the cameras in these smartphones were set to automatic mode with automatic ISO with the Flash in automatic. Using the aforementioned equipment two groups of images were produced. The first group consisted of three images for the face and five images for the oral cavity. The face images were Frontal, frontal smiling and profile views of an adult patient and one pediatric patient. And the oral cavity five images were frontal, right and left lateral, maxillary and mandibular occlusal views of an adult patient and one pediatric patient. The second group of images consisted of small objects images, which were dental polishing brush, a hand piece round bur #6 bur, and a bonding micro brush **Fig. (2)**. Any dentist or a dental student can relate these objects, as they are in general use. After the images were acquired. The images were transferred for evaluation on a personal computer monitor (**Dell OptiPlex, USA**) which were displayed in full size as well as magnified 5× and 15×. To verify the same magnification for all three objects placed close to a millimeter scale. Additionally twenty (20) pediatric patients were imaged by the DSLR cameras, bridge camera and smart phones to assess the acceptance of each piece of equipment used in study on a scale range from (0-1), in which 0 represents refusal and 1 represents acceptance. After obtaining the images, the images were downloaded and cropped using Adobe Photoshop software (version CC 2019, adobe corporation, USA). The cropping was done with a ratio of 16:9. The image output size was set to 1080 × 1920 pixels. Then, the images were saved in JPEG format with maximum quality. Without manipulation regarding brightness, contrast, saturation, or any other tunings. <sup>(8)</sup> The images arranged in a questionnaire using Google Forms. A total of 90 evaluators were included in the study The participant, divided into three main group under-graduate students (**Group 1**) (**n=30**) graduated dentists (**Group 2**) (**n=30**) and graduated dentists with photography experience (**Group 3**) (**n=30**).The participant required to assign

scores to each image set and write the score in the specific area in the questionnaire. The criteria for choosing the proper score is based upon the opinion of the participants regarding image quality. The criteria for good image quality included the sharpness of the images (clear with good details or blurry with lack of details), color accuracy (good colors and saturation or low saturation with grayish colors), and lack of distortion of images (accurate dimensions or more squeezed / stretched). Scores between (0-10) allocated for each one of the three criteria mentioned earlier. Simple explanations were provided for the participants regarding the study criteria and who to make scores. No interference was made upon evaluators regarding their judgment and perception. A term of free, informed consent affixed to the questionnaire, together with the research criteria of inclusion. The scores were analyzed using ANOVA, followed by the Tukey test ( $\alpha = 0.05$ ).

## Results

The means obtained for the documentation and small objects photographs by (Group 1), (Group 2) and (Group 3) shown in Fig. (3) & Fig. (4). For all groups (evaluators / equipment) tested in this study, the DSLRs with macro lenses and ring flashes scored the highest means with statistically significant differences ( $p < 0.05$ ), with no significant difference between 90 mm and 105 mm macro lenses. Followed in scores by the DSLR group with or without extension plus the 50 mm lens and the ring flash the Fujifilm FinePix S4800 bridge camera, the smartphones group, and finally the DSLRS with 18-55 mm lens and pop up flash scored the lowest. From 20 pediatric patients photographed by each equipment used in this study 18 children accepted smartphone photography, 10 accepted the camera and phones, 2 of the children refused photography in both methods. For all three groups of evaluators no statistically significant differences were found among their evaluating scores for all tested cameras and for both groups the

documentation and small objects photographs ( $p > 0.05$ ).

## Discussion

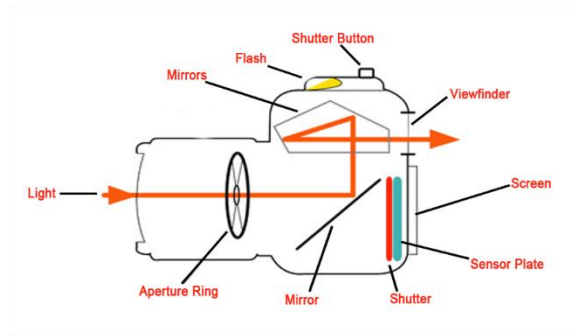
Undoubtedly, the DSLR camera is the gold standard in dental photography. The results obtained from this study indicate that DSLRs equipped with macro lenses and ring flash scored much better than other tested groups. Older models of DSLR camera as the Nikon D 3200 and d40, showed that they are still capable of producing proper images for dental proposes, when equipped with suitable lens and lightning, which is a good option for dental students or those dentists with limited budget and start more professional approach to record their cases. <sup>(8, 17)</sup> This is attributed to sensor size, which is higher for DSLRs. The Nikon cameras used for this study have approximately 24x16 mm APS-C sensors. In contrast, the smartphones and bridge cameras, which have sensors that do not exceed 1/3 of size of that of APS – C DSLR camera sensor. Big sensors have superior pixels, which catch a larger quantity of light compared with small sensors, resulting in higher quality images with regard to definition and sharpness <sup>(10)</sup>. Furthermore, the superior lenses of DSLR cameras with great optical qualities and lack of distortions and accurate focal lengths also contribute to the results. In spite of the better quality images, using a DSLR with an extension tube should be avoided because of being a cumbersome approach that requires being very close to the patient to obtain proper images. Bridge cameras are good to learn photography, less intimidating than using DSLRs; however, they lack the proper sharpness, and produce distortion, due to small sensor size, and using fixed non-interchangeable lenses, with multiple glass elements, that cause softness of images. Using popup flash and difficulty to adapt ring flash or other lightening devices, as many models lack hot shoe adapter, or threads to attach ring flashes, therefore they are not suitable for proper dental documentation and diagnostic needs. The illumination deficiency is apparent explanation for the

poor performance of 18-55mm lens with DSLR cameras when used without a suitable macro ring flash. The built-in pop-up flash located on top of the body of the camera is distant from the lens, preventing adequate illumination in macro pictures casting shadows on the posterior teeth and overexposing the anterior teeth, (1, 17). On smartphones, the flash camera lenses are more compact and close to each other, spawning enough illumination. The distortion caused by using the short focal length of the 18-55 lens is another factor for poor results of these groups. (11-14). The better illumination in addition to incorporation of a macro lens in their camera assembly with sophisticated computing power along with small minimum working distance is responsible for better performance of smartphones. However, the focal length of the smartphone lenses is much shorter than that of DSLR cameras with fixed wide aperture opening ranging from 1.8 to 2.2, which is responsible for lack of sharpness. Smartphone lenses made of plastic with poor optical performance when compared with glass elements of camera lenses, all these factors directly related to the unwanted distortions of proportions when the image obtained at a short distance. DSLR macro lenses, with focal lengths of 90 mm to 105 mm with minimum aperture opening reaching up to 32 and more, do not exhibit this setback. (11) The distance of 30cm to 40 cm from the patient is the distance suitable for documentation photography DSLR cameras associated with macro lenses can accommodate this. The lower performance of smartphones is also related to the small sensor size and the higher noise generated due to compression of many pixels in smaller

areas which become evident with macro photography when darker fields are imaged and pixels are pushed to their limits seeking light. In spite of the ease of use, acceptance and convenience of using smartphones for making dental images ,especially when photographing pediatric patient, who are familiar with smartphones and showed less fear unlike with other cameras used in this study, the results are still inferior to those of DSLRs, probably to the factors mentioned earlier (15,16). No significant differences were found among smartphone groups tested in this study but a minimum of a 12 MP camera with a dedicated macro lens assembly is essential to obtain adequate results. (17, 18)

## Conclusion

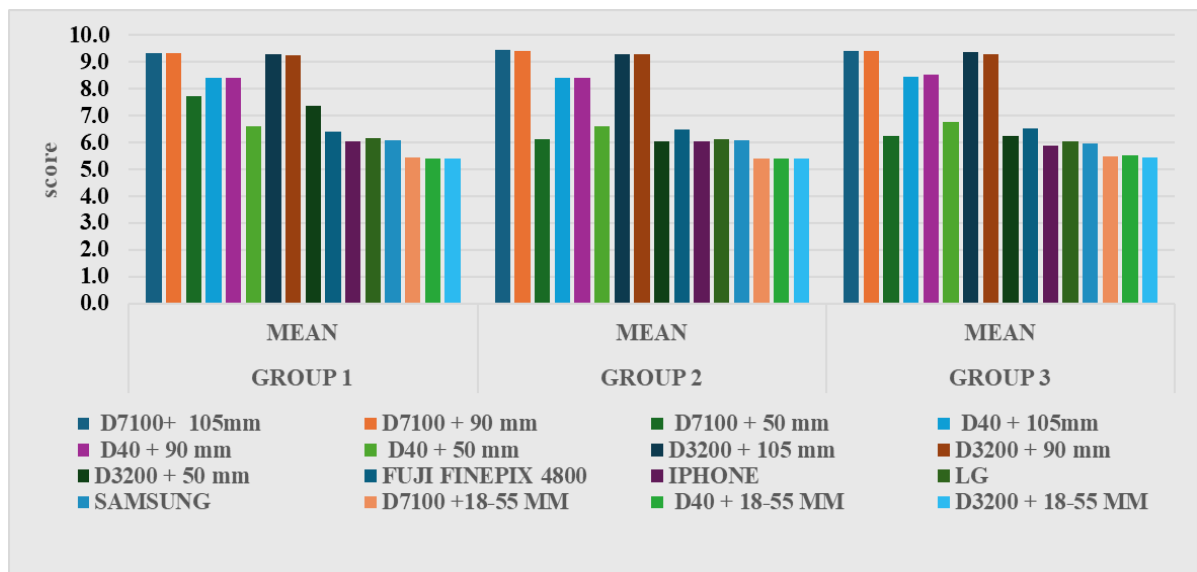
Camera body is the least important part for making appropriate images for dental clinical work. Using a macro lens of and suitable source of illumination are critical for producing images of workable quality .Older models of DSLRS are still adequate for dental photography and surpass smartphones in image fidelity. Bridge cameras and smartphones are ineffective for serious dental photography and proper documentation of dental cases. Avoidance of kit lenses or extension tubes with built in flashes for dental photography. The acceptance is better for pediatric patients when photographed with smartphones.



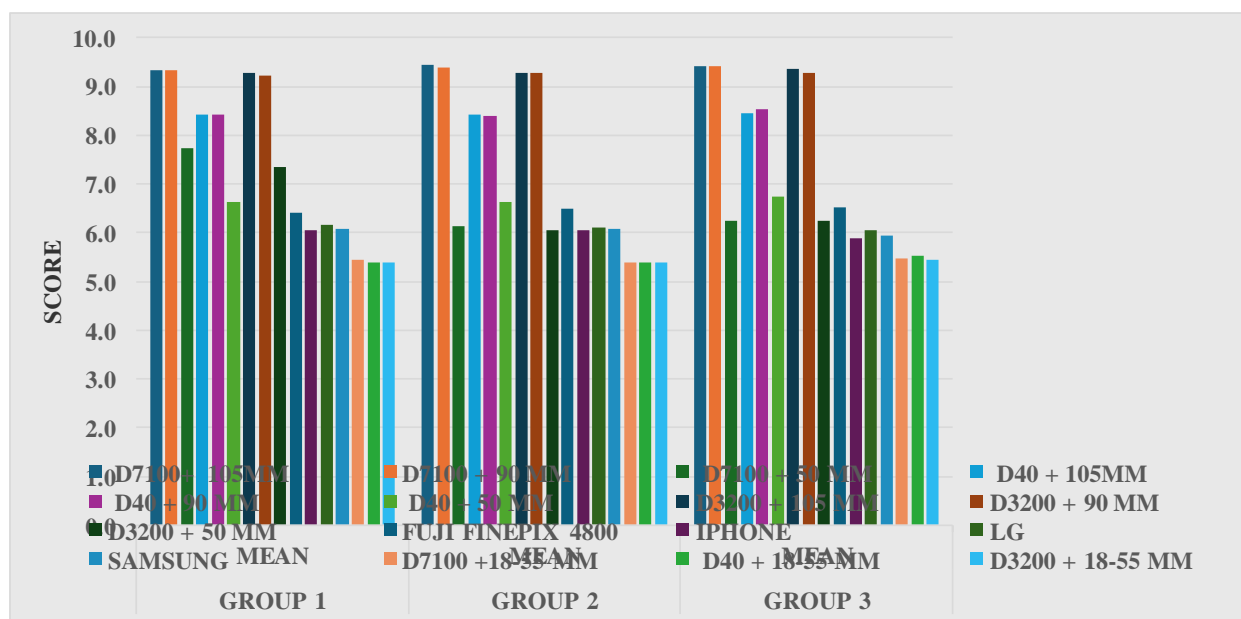
**Fig. (1): Digital single lens reflex (DSLR)**



**Fig. (2) Dental documentation images (intra oral views) along with small objects images used in this study.**



**Fig. (3): Mean, ascribed to each equipment by Group 1 (n=30), Group 2 (n=30) and Group 3 (n=30) for photographs of small objects**



**Fig. (4): Mean ascribed to each equipment by the Group 1 (n=30), Group2 (n=30) and Group 3 (n=30) for dental documentation images.**

**Table (1): photography equipment used in the study along with their specification.**

Equipment name	Equipment image	Sensor
<p>Nikon D7100 Nikon Corporation, Thailand</p>		<p>Resolution: 24 MP 23.6 mm × 15.6 mm Nikon DX format APS-C(advanced photography system cropped)  RGB CMOS sensor, 1.5 × FOV crop, 4.78 μm pixel size</p>
<p>Nikon D40 DSLR Nikon Corporation, Thailand</p>		<p>Resolution: 6MP Nikon DX APS-C format 23.7 mm × 15.6 mm (0.93 in × 0.61 in) CCD</p>
<p>Nikon D3200 Nikon Corporation, Thailand</p>		<p>Resolution: 24MP 23.2 mm × 15.4 mm Nikon DX format APS-C RGB CMOS sensor, 1.5 × FOV crop, 3.85 μm pixel size</p>

<p>Fujifilm FinePix S4800 Bridge Camera, Fujifilm corporation, China</p>		<p>16MP - 1/2.3" CCD Sensor</p>
<p>LG V20 LG Electronics Inc., Korea</p>		<p>16 MP, f/1.8, 29mm(standard), 1/2.6", Laser AF, 3-axis OIS</p>
<p>Samsung Galaxy Note5 Samsung Electronics Co., Ltd. , Korea</p>		<p>16 MP, f/1.9, 28mm (wide), 1/2.6", 1.12µm, AF, OIS</p>
<p>Apple iPhone 8 Apple Inc., USA</p>		<p>12 MP, f/1.8, 28mm (wide), PDAF, OIS</p>
<p>Nikon 50 mm lens Nikon Corporation, China</p>		<p>50mm f/1.8 D</p>
<p>Tamron 90 mm macro lens, Tamron Co., Ltd. , Japan</p>		<p>Tamron SP AF 90mm F/2.8 Di Macro 1:1 Lens for Nikon</p>

<p>Meike Extension tube. Meike Digital Technology Co., Ltd. China</p>		<p>Meike Auto Focus Macro Extension Tube Set Metal Mount 12mm 20mm 36mm for Nikon AF AF-S DX FX SLR Cameras</p>
<p>Meike ring flash Meike Digital Technology Co., Ltd. China</p>		<p>Meike LED Macro Ring Flash Light for Nikon DSLR Camera with Hot Shoe Mount</p>

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