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Research article

Comparison of color accuracy and picture quality of digital SLR, point and shoot and mobile cameras used for dental intraoral photography – A pilot study

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ABSTRACT

The present study aimed to compare the picture quality and color accuracy of three cameras, namely, Point and shoot, DSLR and mobile cameras, and determine the most suitable camera for dental photography (intra-orally and for casts). A computer program, namely, NRM (No-Reference matrix BRISQUE), was used to evaluate the quality of the photos taken by three cameras. Further, color accuracy was determined by computation of total color difference (**ΔE**) by identifying the L*a*b* values.

The ANOVA (Kruskal-Wallis) analysis was done to assess the difference in the quality of cast photos, and it showed a statistically significant difference ($p < 0.05$) between the cameras. The post hoc analysis showed the NRM value of Point and shoot (18.93 ± 2.04) better than the Mobile phone (20.59 ± 2.65). However, no statistically significant difference was obtained while assessing the picture quality of the intraoral photographs using One-Way ANOVA (Fisher's) ($P = 0.05$).

Evaluation of total color difference (**ΔE**) showed fewer differences between the DSLR and the Point and shoot than the mobile camera. There was no statistically significant difference in ΔE value in the participant photographs. The L in the LAB values of both the cast and the participant photograph showed a similar result, with the mobile phone showing a lighter value than the other two cameras. The B value in the participant photos showed a significant difference between the mobile and the Point and shoot cameras.

The quality of Point and shoot, DSLR, and mobile cameras were equally good for taking pictures of any external surface, but the mobile camera offered more brightness and appeared more yellow. On the other hand, the quality was similar for intraoral images with mobile and Point and shoot cameras, although color accuracy was better with Point and shoot and DSLR cameras.

1. Introduction

Diagnostic challenges in dental health care and the effectiveness of treatment modalities mandate the quality and accuracy of dental photography. Easy access to high-resolution images has made this possible. Literature has previously cited various cameras and additional equipment used to take photographs in dentistry [1, 2, 3, 4, 5]. The 'photograph' is credited most often as an essential method of documentation, while coincidently also promising to capture and unveil the mystic of the dark environs, especially of the oral cavity, enhancing its vibrant hues. However, with technology becoming ubiquitous in almost every aspect of life, it is easy for information to be misinterpreted or even misrepresented. As a result, many dentists from all specialties fear photography due to the dogma of unseeingly 'complex' technicalities, 'incomprehensible' digital language, and undoubtedly the 'expense'.

The no-reference algorithm (BRISQUE) is a blind/reference image spatial quality evaluator program close to the evaluation capacities of humans. It is based on the principle that images possess specific regular and natural statistical properties, and when there is a distortion, it can be measured. The distortion can be quantified and measured using an algorithm capable of assessing the perpetual quality of an image

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without the need for a reference image [6]. BRISQUE is one such algorithm that has been utilized to check the quality of photographs. Algorithms are available to assess image quality utilizing a reference image [7]. Experimental results show that BRISQUE has an excellent predictive ability, and the evaluation effect is better than existing classical algorithms [8].

NR algorithms are based on Natural Scene Statistics (NSS) [9, 10, 11] and are developed in the LIVE group [12, 13]. It is based on several factors such as sharpness, noise, dynamic range, tone reproduction, contrast, distortion, lens flare, and artifact.

The interpretation of photographs may differ between individuals or individuals and software due to variations in color perception. In 1976, the International Commission on Illumination gave the CIELAB formula, which describes a color close to human eye perception. 'CIELAB' provides a complete numerical color descriptor in a rectangular coordinate system. L* represents lightness, a* represents red to green, and b* represents yellow to blue. The color difference between a sample or lot and a standard or target color can be represented by its lightness, redness or greenness and blueness and the yellowness between the sample and standard colors. The **ΔE** or **ΔE*** is derived from the German word "Empfindung," for sensation, and it measures the "difference in sensation" [14]. The CIELAB has been used in previous research to interpret variations in color patches between photographs [15, 16, 17, 18].

The camera commonly used and considered adequate for dental photography is the professional DSLR camera [19]. The Digital Single Lens Reflex (DSLR) camera, along with the 100 mm macro telephoto lens, has been used by researchers for its consistent results that work on the principle of "through the lens [20]." Moreover, 'DSLR' allows one to customize different lenses based on the situation, unlike the 'mobile phone' and 'Point and shoot' cameras [21].

Mobile phone cameras typically use wide-angle, fixed lenses, which are suboptimal for close-up images. In addition, it has a single standard focal length (distance between the lens and image sensor) and a small sensor size, allowing more significant distortion in the final image [22]. Nevertheless, the mobile phone images have been shown to have a good agreement with a dentist [23]. However, despite technological advancements, cameras on mobile phones are still limited compared with dedicated camera systems.

Most "Point and shoot" cameras cannot provide clinically correct photographs. A select few models have the proper combination of flash placement, macro-options, and depth of field capabilities [24]. However, this camera will focus at any distance from the object or the participant. Hence the images cannot be standardized to 100%. Furthermore, rendition of color would change with the environmental lighting condition.

In the present scenario with limited research on these cameras, it was interesting to assess the color accuracy and picture quality of dental photographs (on casts and in willing human participants) taken by a DSLR Camera, Point and Shoot Camera, and Mobile Phone. Hence the present study aimed to determine the more suitable camera for picture quality and color accuracy when Point and Shoot, DSLR, and Mobile cameras were compared. The outcomes of the study have been achieved through the following objectives.

2. Objectives

a. To evaluate the picture quality of the photos using the NRM and select the best among the three cameras for dental cast and dental intraoral photography.
b. To evaluate the color accuracy and the total color difference (**ΔE**) of the photos using the CIELAB and select the best among the three cameras for dental cast and dental intraoral photography.

3. Materials and method

3.1. Materials

3.1.1. Casts

The casts used for the photography were dental plaster models having ideal Angle's Class I occlusion (Figure 1). These casts were coated with acrylic paint to mimic the teeth, the attached gingiva, and alveolar mucosa and placed on a fixed platform with a black background for achieving good contrast.

3.1.2. Cameras

This study used three different cameras with dissimilar formats to take dental photographs. They include the DSLR camera, Point and shoot camera, and mobile phone, each with their inbuilt flashes.

The Canon' Point and Shoot' camera (Canon PowerShot ELPH 180, US, 2018) [25] has an in-built wide-angle lens with the 8X Optical Zoom. The mobile phone camera (Apple iPhone 6, US) was selected for this study due to its popularity and features. The mobile phone is equipped with 12 megapixels, autofocus with focus pixels, true tone flash, exposure control, f2.2 aperture. It also consisted of auto image stabilization, local tone mapping, 5x digital zoom, dual-LED flash, and noise reduction camera. (iPhone 6 Technical Specifications, 2018) [26]. A camera app was installed to help determine the exposure values while taking photographs. The DSLR Camera was an EOS1300D Canon body with the Canon EF 100 mm F/2.8 IS macro lens.

Any photograph is based on the exposure triad, including ISO, Aperture value (f - value), and Shutter Speed. The DSLR cameras allowed these three adjustable exposure values. On the other hand, the mobile phone camera allowed the ISO and Shutter Speed modification with the DSLR Camera App. The Aperture Value (f) of the mobile phone and Point and shoot camera will not be adjustable due to the non-adjustable built-in lens but only allowed adjustment of the ISO. The auto mode was utilized in this study to keep the uniformity of default settings in all three types of cameras. Hence during capture, it would help better understand the internal mechanism and assess each camera's capacities' of analyzing real-life scenarios and capturing the crucial aspects. All photographs were taken in JPEG mode to ensure uniformity with the results.

3.2. Methodology

3.2.1. Procurement of the cast photos taken by three cameras

Photographs of the following five regions were taken: Right and Left Posterior Aspects of the Casts with Maximum Intercuspation, occlusal view of Maxilla, occlusal View of Mandible, and frontal view of upper-lower teeth in occlusion with each camera (Figure 1). Four pictures were taken of each view, with a maximum of twenty photographs taken with each camera. Distance of 0.48 m (1.52 feet) and 1: 3.2 Magnification Ratio (for DSLR Camera) were maintained while taking the photos. Ten photographs were taken every day for six consecutive days in the same season in the same room with the same lighting to be consistent with the environment and light settings by a single examiner RS. Subsequently, these 60 photographs were rearranged randomly to conceal the camera from which the photos were sourced.

3.2.2. Procurement of intraoral photographs of participants

The photos of the participants were taken only after obtaining approval from the Institutional Ethics Committee (IEC No. – 53/2018). These participants attended the Periodontics out-patient clinic and were given the participant information sheet. They were invited to participate in this study if they were fully dentulous and willing to participate. Participants were excluded if edentulous, with a fixed or removable prosthesis, mentally challenged, physically ill, and unwilling to participate.

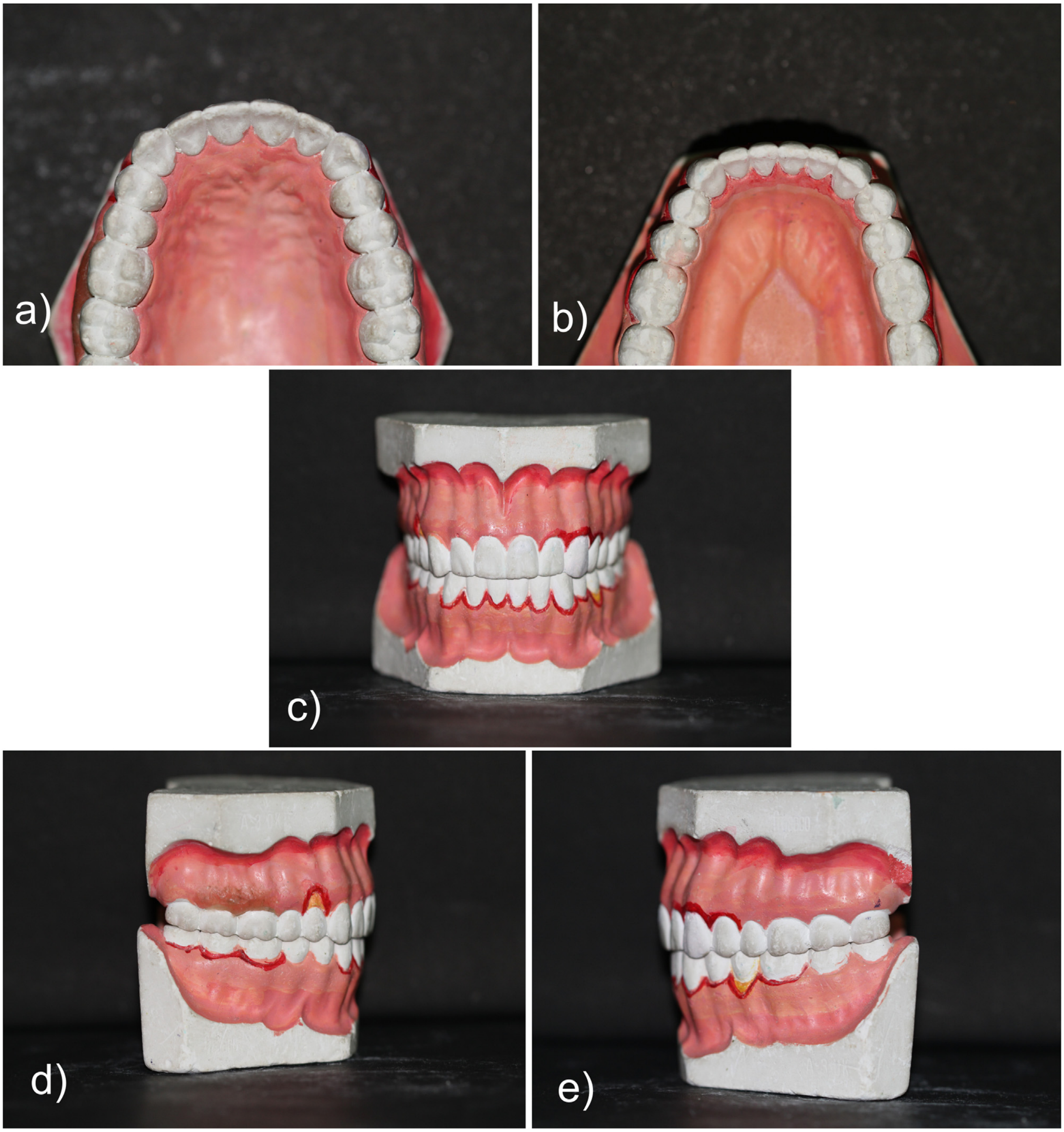

Figure 1. Photographs of five regions of the dental cast taken by the cameras a) Maxillary occlusal view, b) Mandibular occlusal view, c) View in occlusion, d) Right lateral view in occlusion and e) Left lateral view in occlusion.

After obtaining 'prior informed consent, a total of 26 patients were enrolled in the study. Ten patients were excluded based on the inclusion and the exclusion criteria and the poor quality of the pictures. A total of 192 photos were obtained from the remaining 16 patients with all three cameras in auto mode by a single examiner, RS. These images were coded as A for mobile phones, B for Point and shoot, and C for DSLR photos. A second examiner, SK, blinded to the type of camera used, selected a total of 96 pictures that included 32 photos per camera for the image quality and color accuracy assessment.

The photographer, RS, had completed a course on dental photography and was well versed in obtaining photographs with all three types of cameras. The participants were asked to close their mouths to relax the buccinator muscles for buccal images, allowing room to place unilateral cheek retractors. Images were taken with the participants seated in a comfortable position. The area intended to be photographed was cleared of debris and saliva. Isolation was obtained with the plastic cheek retractors with teeth in occlusion to concentrate on the maxillary/mandibular teeth and the gingiva. The region of interest was photographed using the landscape mode. The images were cropped and stored as a JPEG file (Figure 2).

The soft copies of the cast photographs and the participants' intraoral photographs were anonymized, coded and arranged randomly to eliminate the bias. A third examiner MM checked the image quality and the color accuracy of all the photographs (Figure 3).

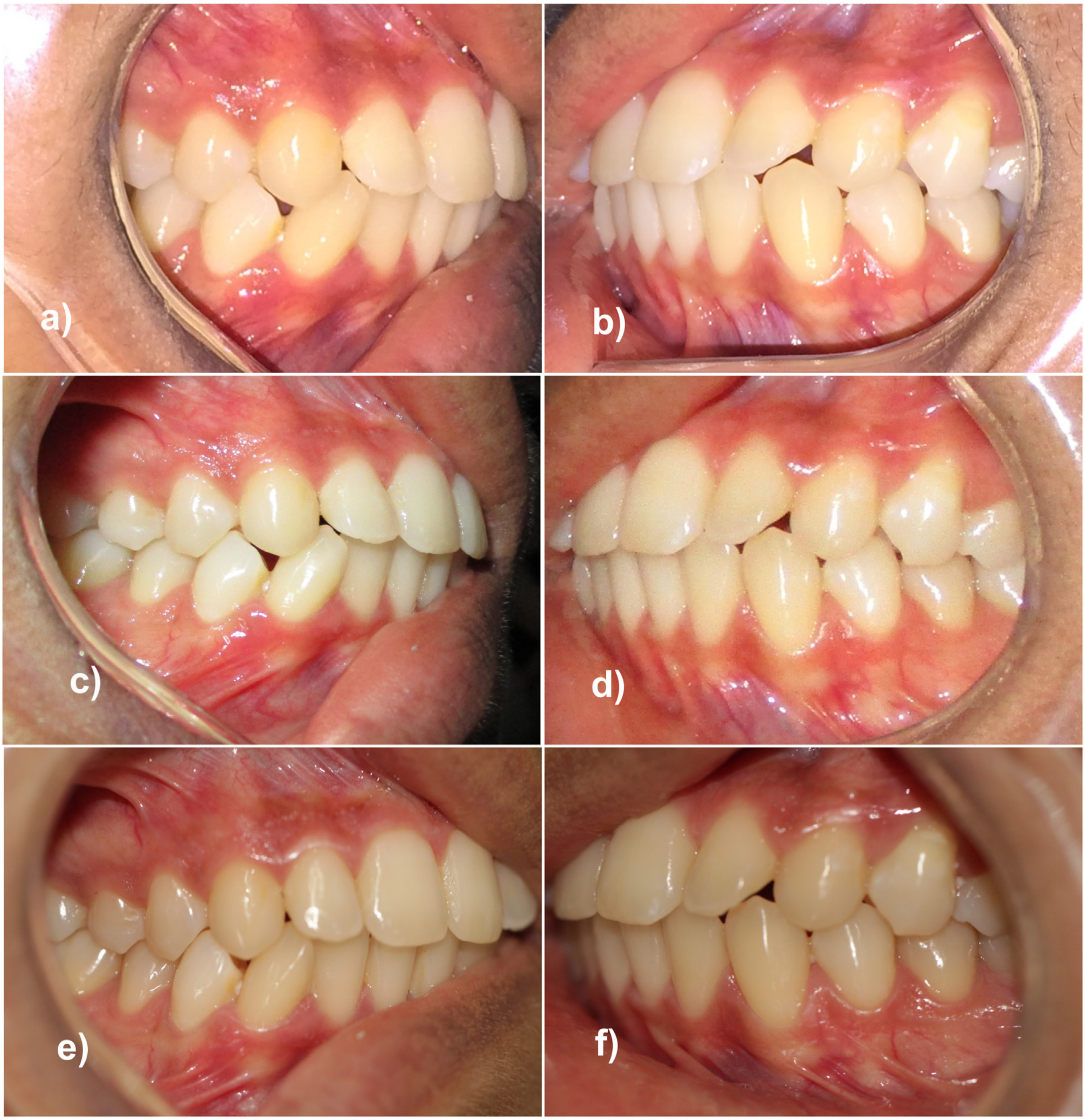

Figure 2. Intraoral photographs of left and the right lateral views of the teeth in occlusion. a) and b) taken using the mobile phone, c) and d) taken using the Point and Shoot, e) and f) taken using the DSLR Camera.

3.2.3. Assessment of the picture quality and color accuracy between the cast and the intraoral photos that were taken by three cameras

All the photographs were transferred to the computer, and the NRM (BRISQUE) algorithm was used to check the image quality, and the CIELAB was used to analyze the color accuracy (Matlab software version 9.5, release name R2018b, Sep 2018).

The color accuracy was assessed by identifying the L*a*b* values of the photographs. The values expressed were L* for the lightness from black to white, a* from green to red, and b* from blue to yellow. For the L value, 0 was for black color, and 100 represents a perfect reflecting diffuser. The a* and b* axes have no specific numerical limits. Positive a* is red, and negative is green. Positive b* is yellow, and the negative is blue [27]. The total color difference (ΔE) was calculated to estimate the distance between the colors when assessed by different cameras. The total color difference was computed based on Eq. (1), thus obtaining the distance between the color values that gave the closeness to the respective readings of the colors.

$$\Delta E^*_{ab} = \sqrt{\left(L^*_2 - L^*_1\right)^2 + \left(a^*_2 - a^*_1\right)^2 + \left(b^*_2 - b^*_1\right)^2} \quad (1)$$

4. Results

4.1. Assessment of picture quality of cameras taking cast and the photograph of the participant

4.1.1. The picture quality of dental cast photographs

The descriptives show the median NRM score of mobile phone, Point and shoot, and DSLR camera was 20.59; 18.93; and 18.45 respectively

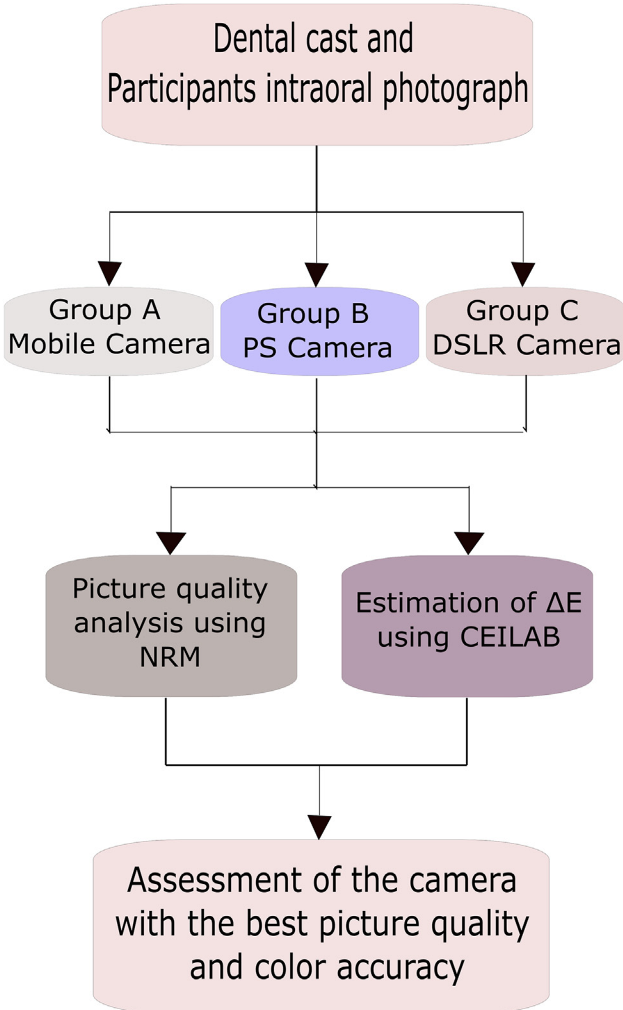

Figure 3. Flowchart showing the distribution of different groups.

(Table 1). The assessment of the normality using the Shapiro-Wilk showed the values to be not normally distributed. Hence, to assess the statistical significance, the Kruskal-Wallis test was done. The test showed a statistically significant difference between the three cameras in assessing the picture quality of the cast, as shown in Table 2 with $p < 0.05$. Post-hoc analysis was done using Dwass-Steel-Critchlow-Flinger pairwise comparisons showing a significant difference between the mobile and Point and shoot $P = 0.047$ ($P < 0.05$). The mobile phone showed a higher NRM value than Point and shoot, suggesting the lesser quality of images of mobile phones than Point and shoot. There was no significant difference between the Point and shoot and the DSLR cameras.

4.1.2. The picture quality of intraoral photographs

The participants' intraoral photographs showed no statistically significant difference between the three cameras when their picture quality was assessed ($p \geq 0.05$).

4.2. Assessment of color accuracy of cameras

4.2.1. Color accuracy of dental cast photographs

ΔE: The least mean total color difference value of 9.51 was between the Point and shoot and the DSLR, and the difference was maximum between the mobile and the Point and shoot at 14.97. The total color difference values were normally distributed between the groups with $p = 0.323$. The one-way ANOVA analysis showed a statistically significant difference between the groups ($p < 0.05$) (Table 3). Furthermore, the post-hoc Tukey test showed a significant difference in the **ΔE** values between the Mobile phone/PS and PS/DSLR, suggesting the color difference to be less between the Point and shoot and the DSLR.

The L′A′B′ values of the casts were tabulated (Table 5), and the mean and the median scores were analyzed. The L′ values were not normally distributed, but the A′B′ values were normally distributed.

L′ values showed a statistically significant difference between the groups with ANOVA analysis (Table 6), and the difference was statistically significant when the mobile phone was compared either with the Point and shoot camera or the DSLR camera. The mobile phone camera photographs showed lighter scores than the other two cameras.

A′ and B′ values showed no statistically significant difference between the cameras when one way ANOVA was done (Table 6).

4.2.2. Color accuracy of participant's intraoral photographs

ΔE: There is no statistically significant difference between the groups. It was observed that all the total color difference values appeared to be very close to each other. The distance between the Point and shoot and DSLR was comparatively lesser than the other two combinations ($p < 0.05$) (Table 4).

One Way ANOVA test was carried out as the LAB value was normally distributed (Table 5). It showed a significant difference between the three cameras (Table 6). The post hoc analysis (Games-Howel) showed the L value was relatively more (67 ± 4.58) in the mobile camera photos compared to Point and shoot (54.3 ± 10.46) and DSLR (40.5 ± 9.38) cameras. There was no difference in the A values among the groups, but the post hoc analysis showed B values of the mobile camera to be more towards yellow shade (19.5 ± 5.84) when compared to the Point and shoot (24.6 ± 5.82) or DSLR (21.6 ± 3.57). Hence, we construe that the DSLR and the Point and shoot cameras were equally suitable for intraoral photography in picture quality. Concurrently, although the mobile camera had good picture quality, there was more brightness and more

Table 1. Descriptives values of the NRM and the DE values of the cast and the participant photographs taken by three cameras.

	Cameras	N	Mean	Median	SD	Shapiro-Wilk	
						W	p
NRM Ct	Mob	20	20.44	20.59	2.65	0.980	0.936
	PS	20	18.49	18.93	2.04	0.817	0.002
	DSLR	20	19.39	18.45	3.69	0.756	<.001
ΔE Ct	Mob-PS	20	14.97	13.77	5.21	0.974	0.845
	PS-DSLR	20	9.51	8.51	4.26	0.921	0.101
	DSLR-Mob	20	12.73	12.52	4.33	0.962	0.591
NRM Pt	Mob	20	20.44	20.59	2.65	0.980	0.937
	PS	20	18.51	18.91	2.04	0.812	0.001
	DSLR	20	19.39	18.46	3.69	0.756	<.001
ΔE Pt	Mob-PS	20	30.36	21.68	26.36	0.847	0.005
	PS-DSLR	20	22.43	18.76	12.39	0.764	<.001
	DSLR-Mob	20	29.31	29.46	9.92	0.952	0.394

Table 2. One-Way ANOVA (Non-parametric) Kruskal-Wallis and Dwass-Steel-Critchlow-Fligner pairwise comparisons.

	χ^2	Df	P
NRM Ct	6.10	2	0.047*
Pairwise comparisons - NRM Ct		W	P
Mob	PS	-3.347	0.047*
Mob	DSLR	-2.678	0.141
PS	DSLR	-0.325	0.971

*Statistically significant difference $p < 0.05$.

Table 3. One-Way ANOVA (Fisher's)* test to check the statistical significance between the ΔE values of the Cast photographs taken by three cameras.

		F	df1	df2	P
ΔE Ct		7.05	2	57	0.002**
Tukey Post-hoc Test			**Mob-PS**	**PS-DSLR**	**DSLR-Mob**
Mob-PS	Mean difference		-	5.46	2.24
	p-value		-	0.001**	0.284
PS-DSLR	Mean difference			-	-3.22
	p-value			-	0.079
DSLR-Mob	Mean difference				-
	p-value				-

*Levene's test to check the homogeneity of variance $p > 0.05$.
**Statistically significant difference between the groups $p < 0.05$.

yellowness to the final color of the pictures. Further, the point and shoot and DSLR's total color differences were comparable.

5. Discussion

Acquiring instant photographic images is essential for a health professional, as is the quality of the acquired images [28]. This constant search for image quality has paved the way for Image Quality Assessment (IQA) metrics. IQA offers a simplistic approach, close to human perception, for evaluating any image [29]. However, there are some problems in image quality assessment, namely, type of distortion in the image, ability to consider human visual characteristics thoroughly, and variable reference/original images. Therefore, the BRISQUE and the Modified BRISQUE have been used for image quality assessment. In addition, modified BRISQUE has specifically been used for analyzing MRI images [30, 31].

The present study has relevance in identifying the color accuracy and picture quality of different types of cameras, using NRM and CIELAB color space, which are standard color and quality measurement software [32]. Another way to assess the photographs' color is the Munsell color order system, which, unlike the CEILAB, is represented on a colored chip for visual matching and is arranged in a 3-dimensional space (CIE publication No. 15.2, 1986). The value (V), hue (H), and chroma (C) have correlations to the L*a*b* values of CEILAB. The study done by Alvin G Wee (2006) showed the results **ΔE** values were lower for the CEILAB color space, and the findings were not supportive of the superiority of the XYZ color space. Hence it was concluded that when checking the color quality, the error was minimum with the CEILAB color space [32].

In the cast photographs, the mean NRM values of the mobile phone were 20.44 ± 2.65, Point and shoot had a mean of 18.49 ± 2.04, and the DSLR cameras had a mean of 19.39 ± 3.69. The noticeable mean of the difference in the color sensation (**ΔE**) between the mobile and the Point and shoot camera values were 14.97 ± 5.21, between the Point and shoot and the DSLR was 9.51 ± 4.26 and the DSLR and the mobile phone was 12.7 ± 4.3. The NRM values for the cast photographs shown in this study had no difference statistically between the groups, but there was a statistically significant difference in the mean of the difference in sensation (**ΔE**) with DSLR and the Point and Shoot camera showing the sensation of the color close to each other compared to the mobile phone. Hence, there was a better perception of color by the DSLR and the Point and Shoot camera.

In the case of participant photographs, the quality of the pictures taken by the DSLR was much lower, and there was no difference in sensation between the groups. However, there was a significant difference in the L values, which indicates that the mobile and the Point and Shoot camera have brighter images than the DSLR camera images. In literature, the comparison of different models of the DSLR cameras and the difference in color sensation ranged from 1.79 to 5.25 after proper calibration [32]. However, the difference in the present study ranged from 9.5 ± 4.3 to 12.7 ± 4.3 between the DSLR and the other two cameras; this could be due to the variable calibration (auto mode settings) between the cameras, the absence of controlled illumination, and the different types of cameras used.

With the recent trend of cameras installed in mobile phones, one may be more inclined to use these easily accessible products. 'Smartphones' have shown promising results in diagnosis and proved to be as good as the gold standard in sharing the cases of dental trauma. A report by

Table 4. One-Way ANOVA (Non-parametric) Kruskal-Wallis test and Pairwise comparison using the Dwass-Steel-Critchlow-Fligner to assess the NRM and the ΔE values of the participant photographs obtained from three cameras.

	χ^2	df	P
NRM Pt	5.99	2	0.050
ΔE Pt	5.27	2	0.072
Pairwise comparison – NRM in participant photo		**W**	**P**
Mob	PS	-3.290	0.052
Mob	DSLR	-2.678	0.141
PS	DSLR	-0.497	0.934
Pairwise comparisons – ΔE in participant photo		**W**	**P**
Mob-PS	PS-DSLR	-0.937	0.785
Mob-PS	DSLR-Mob	1.645	0.475
PS-DSLR	DSLR-Mob	3.520	0.034*

*Statistically significant difference $p < 0.05$.

Table 5. Descriptives of LAB values of the cast and the participant photographs taken by three cameras.

	Cameras	N	Mean	Median	SD	Shapiro-Wilk	
						W	P
L′	Mob	20	68.3	70.0	4.11	0.832	0.003
	PS	20	55.3	56.0	5.92	0.937	0.210
	DSLR	20	58.0	58.0	6.42	0.984	0.973
A′	Mob-PS	20	41.9	42.0	5.40	0.950	0.369
	PS-DSLR	20	39.1	38.0	4.46	0.965	0.645
	DSLR-Mob	20	37.8	39.0	4.97	0.936	0.201
B′	Mob	20	20.9	21.0	2.80	0.929	0.146
	PS	20	21.7	22.5	4.90	0.930	0.156
	DSLR	20	19.2	18.0	2.76	0.940	0.242
L	Mob	20	67.0	68.0	4.58	0.909	0.061
	PS	20	54.3	55.0	10.46	0.923	0.115
	DSLR	20	40.5	42.0	9.38	0.949	0.348
A	Mob-PS	20	31.7	32.5	5.67	0.937	0.207
	PS-DSLR	20	31.0	32.0	5.29	0.937	0.212
	DSLR-Mob	20	28.0	27.5	3.63	0.942	0.264
B	Mob	20	19.5	19.0	5.84	0.949	0.356
	PS	20	24.6	26.0	5.82	0.946	0.308
	DSLR	20	21.6	21.0	3.57	0.967	0.680

Table 6. Non- parametric One Way Anova (Kruskal-Wallis) and One Way ANOVA (Welch's) analysis of L′A′B′ values of Cast photographs and LAB values of the participant photographs.

Kruskal Wallis	χ^2	Df	P	
L′	31.2	2	<.001	
One Way ANOVA (Welch's)	**F**	**df1**	**df2**	**p**
A′	3.07	2	37.8	0.058
B′	2.73	2	36.4	0.079
L	67.37	2	33.0	<.001
A	3.94	2	36.4	0.028
B	3.83	2	35.7	0.031

Geraldino in 2017 describes the use of the mobile phone as being close to the human interpretation of dental trauma cases [33]. Eduardo K Kohara (2018) and Estai M et al. (2021) found a similar performance in the detection of caries by both smartphones and the DSLR. Notably, the study involved the comparison of each of the cameras with the human standard. The study also interpreted that it was difficult to recognize initial and moderate caries using the two cameras [34, 35]. In another article, Reynolds et al. 2019 describe four easily implemented photographic skills for surgeons using mobiles for patient care. The prevailing context should provide appropriate lighting, dimensionality, and manage distracting elements [36]. However, digital images pass through a process of image acquisition, transmission, processing, compression, and storage. These digital conveniences have significantly caused compromised image quality, bringing forth challenges in its evaluation. Nevertheless, dental surgeons still rely on these small accessible cameras for documentation due to their phobia of 'complex' technicalities, 'incomprehensible' digital language, concern regarding movement artifacts, and difficulty focusing [19].

Point and shoot cameras are better with the flash and external light source [24, 37]. However, the Point and shoot used here did not have any external light source and was used with auto setting. Hence, there is a need to understand the internal setting for the final assessment of the photographs.

Past research has praised the Digital Single Lens Reflex Camera (DSLR) as the best camera option in dental photography. However, the associated sensor dust in the camera can produce hindrances in detecting caries and other minor changes in the gingival colors. Nevertheless, few DSLR Canon cameras have sonic vibrations to overcome these problems [38]. In the present research, the digital camera was used with internal flash and auto settings, which might have had an enormous impact on the overall result obtained from the digital single-lens reflector camera.

The Joint Photographic Experts Group (JPEG) format is perhaps the most widely used file format for the general sharing of digital photos and is used by Point-and-shoot cameras. The JPEG images are a compressed form of the original data captured by a camera sensor. This compression compromises some data while managing the file size. In the present study, we have used the photographs in JPEG format for all three cameras, affecting the outcome and interpretation [36].

Literature regarding mobile phones and their affiliated features is scant [23], and hence the present study intended to traverse this lacuna. Nevertheless, there is still a need to conduct research using optimum environmental settings to explore the potential between and within the camera types. Further, there is a need to assess intra-oral photography of the challenging maxillary and mandibular occlusal views. Analyzing photographs in the raw format would also have provided a better picture quality and color accuracy. The NRM (No-Reference Matrix) could be considered a standard algorithm, but its use in dental image analysis needs further investigation. The limitations in the present pilot work will provide an impetus to further research.

6. Conclusion

Examining the quality of dental photographs is integral to imparting value to oral health care. The computerized assessment in the present study suggested that DSLR and the Point and Shoot cameras were equally good for taking pictures of the dental casts or any external surface. Although the mobile camera provided good photographs, it seemed to offer brightness and more yellowness to the final color of the pictures. However, the picture quality for intraoral photos was better with the mobile and the Point and shoot camera, but color accuracy was better with the Point and shoot and the DSLR cameras. These observations highlight the need to calibrate the cameras and optimize the environmental conditions, which would probably reduce the variation in the image produced and improve image quality.

Declarations

Author contribution statement

Rishi Saincher, Santhosh Kumar, Pratibha Gopalkrishna: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

M. Maithri, Pradeep S: Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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