ORIGINAL ARTICLE Open Access

Comparison of the perceived image quality of intraoral orthodontic photographs taken with DSLR camera and mobile phone camera: A double-blinded prospective study

Lawrence Tan Soon Lee[1], Nurina Ezza Zulkiflee[2], Noraini Abu Bakar[1]*

[1]*Department of Orthodontics, Kulliyyah of Dentistry, International Islamic University Malaysia.*
[2]*Kulliyyah of Dentistry, International Islamic University Malaysia.*

Abstract

Clinical orthodontic photography is a vital skill that every orthodontist should master to record the patients' details and to permit the orthodontist to carefully plan, monitor and execute the treatment. With the advancement of technology, some clinicians opt to take intraoral photographs with their mobile phone rather than DSLR camera. Hence, this study aimed to answer one main question: whether there was any significant difference in the perceived quality image between intraoral photos taken with a mobile phone and a standard DSLR camera. The cameras used were a DSLR (Nikon D300s with AF-S Micro NIKKOR 105mm lens and NIKON R1C1 Twin Flash) and Mobile Phone (Apple I-Phone 11 with Selfie Ring Light). Assessment of 20 sets of intraoral photographs (100 individual images) by five IIUM orthodontists using a perceived quality Likert scale of Zero (0) to Ten (10). The assessors and the lead investigator were blinded to the source of the photographs. Reliability was evaluated using a test-retest method on 4 sets of intraoral photographs (20 individual images), a few weeks after their initial assessment. There was no significant difference (p=0.35) in perceived quality of intraoral photographs taken between DSLR and mobile phone, with the mean value of 7.34 and 7.12 respectively. Reliability was good (ICC=0.549). This prospective study showed that there was no statistical difference between the perceived quality of intraoral orthodontic photographs taken with a DSLR camera and a Mobile Phone camera.

Keywords: *double-blinded prospective study, DSLR camera, mobile phone, intraoral photographs, perceived image, quality*

Received:
13 November 2023
Revised:
28 March 2024
Accepted:
2 April 2024
Published Online:
31 July 2024
How to cite this article:
Soon Lee, L. T. ., Zulkiflee, N. E., & Abu Bakar, N. (2024). Comparison of the perceived image quality of intraoral orthodontic photographs taken with DSLR camera and mobile phone camera: A double-blinded prospective study. *IIUM Journal of Orofacial and Health Sciences*, *5*(2), 153-163. https://doi.org/10.31436/ijohs.v5i2.258
Article DOI:
https://doi.org/10.31436/ijohs.v5i2.258
***Corresponding author**
Address:
Department of Orthodontics, Kulliyyah of Dentistry, International Islamic University Malaysia, 25200 Kuantan, Pahang, Malaysia

Telephone: +60127140094

Email address:
nor_aini@iium.edu.my

Introduction

Photography has been an integral part in dentistry. In orthodontics, photography is vital in order to record patients' details for treatment plan, treatment monitoring and execution of the treatment. It also provides tools for communication between patients and clinician in order to provide a better understanding of the patient's dental problems by displaying the photos.

The gold standard of intraoral photography is by using the Digital Single Lens Reflex (DSLR) camera together with a macro lens and a macro flash/light. Mobile phone (MP) photography however has come a long way in terms of technological advances in sensor quality, resolution, and lens sophistication,

giving much improved image quality over the last few years. It is relatively compact and lighter than a DSLR camera hence younger generation dentists prefer it over conventional cameras (Samawi, 2012). This could be due to the fact that smartphone cameras are more practical, whereby a smartphone is cheaper, lighter and easier alternative than a DSLR camera. It possesses the ability to record high quality photographs and videos. Cameras are chosen due to their availability, popularity, and quality of image (Moussa *et al.*, 2021). Therefore, many dentists nowadays have moved from using DSLR camera to MP as it is more convenient for them.

DSLR cameras have specific settings and characteristics that dictate the protocols of capturing a photograph (Desai & Bumb, 2013). It allows the photographer to control and change settings such as aperture, exposure time, and International Organization for Standardization (ISO) sensitivity (Hardan, 2020). MP cameras perform mainly automatic adjustments allowing the user to take a picture no matter the circumstances which can be both beneficial and disadvantageous at the same time (Majumder & Deen, 2019). On one hand, MP facilitates the process of taking a picture but on the other hand, if the user does not know how to properly manipulate the camera, the photograph can be captured in conditions that compel image distortion (Lee *et. al.*, 2014). In fact, barrel effect is one of the problems that dentists face. It happens when the camera is too close to the subject and results in distorted image proportions (Hardan, 2020). Hence, it was unclear whether MP produces the same standard of image quality compared with DSLR in orthodontic photography. Therefore, this research general objective was to compare whether there was any difference, in the perception of quality of intraoral orthodontic photographs, taken with a DSLR camera or mobile phone camera.

The null hypothesis was there was no difference between the perceived quality of intraoral orthodontic photographs taken with a DSLR camera and photographs taken with a MP camera.

Materials and Methods

Study design

Prospective (double-blinded) quantitative study.

Sample size determination

A sample size was calculated using Epi Info-Sample size for comparing Two Means/Mean Difference (https://www.openepi.com/SampleSize/SSMean.htm). Using the study by Liu et. al. (2020), that had a Mean Score (SD) of 9.41 (0.36), with alpha at 0.05 and beta at 0.2, while noting a mean difference of about 0.47 (5%) to be considered significant, a sample size of 10 sets of intraoral orthodontic photographs will be minimally needed.

Sampling technique

Simple random sampling.

Inclusion/exclusion criteria

Patients with normal range of malocclusions, undergoing conventional orthodontic treatment with upper and lower fixed appliances with or without extractions were included. Patients that had a cleft, dentofacial deformity, impacted teeth, severe hypodontia, undergoing/undergone special treatments (alveolar bone grafts, orthognathic, multi-disciplinary treatments) were excluded.

Study population

The study population was composed of orthodontic patients, who required intraoral orthodontic photographs taken as part of orthodontic records, taking into account the inclusion and exclusion criteria.

Ethical approval

Ethical approval IREC 2022-013 was received from the IIUM Research Ethics Committee (IREC).

Materials

The cameras used were a DSLR (Nikon D300s with AF-S Micro NIKKOR 105mm lens and Nikon R1C1 Twin Flash; year of manufacture: 2011) and a MP (I-Phone 11 with Selfie Ring Light) using back camera 12 Megapixels, used in an orthodontic clinic

with standard intraoral retractors and mirrors. In this study, I-Phone 11 was chosen simply because it is regarded as one of the phones able to take good quality of photos during the time period of the study. The selfie ring light is to mimic the ring flash from the DSLR camera.

Figure 1. From the left is a DSLR Nikon D300S, followed by AF-S Micro NIKKOR 105mm lens and Nikon R1C1 Twin Flash.

The Nikon D300S is a 12.3-megapixel DX format digital single-lens reflex (DSLR) camera. The Nikon D300S has been tested by a number of independent reviewers with favourable reviews. AF-S Micro NIKKOR 105mm lens is the lenses that shine at the 45-degree angle (or similar angles). This narrow focal length can remove perspective distortion that usually seen with wide-angle lenses at similar distances. The lens has a 1:1 magnification ratio which allows a full-size reproduction of the image on the camera sensor. This enables a close-up view of intraoral structures while also preventing distortions to the image. However, lighting can be compromised with close-up photography. The addition of Nikon's R1C1 wireless close-up speedlight system allows capturing most out of the close-up, micro and general flash photography by providing flexible, even lighting of the subjects with the added convenience of wireless control.

Figure 2. From the left is I-phone 11 and followed by the Selfie Ring Flash.

The I-Phone 11 was a premium MP at the time of the study, which is able to obtain pictures at 12 megapixels, the same as Nikon D300S. The wide-angled camera in the I-Phone 11 has a larger sensor with 100 percent more focus pixels that enables new low light capabilities such as a night mode that is designed to take much brighter pictures in low lighting conditions. The selfie ring light was used to mimic the ring flash from the DSLR camera. The ring light allowed for three different settings of white light intensity: low, medium and high.

Camera settings

DSLR was set manually with aperture and shutter speed adjusted according to ambient lighting. MP was set automatically with only exposure compensation and ring light intensity adjusted according to ambient lighting.

Intraoral photography

The five standard views for intraoral photography that are usually taken by an orthodontist which are frontal, right buccal, left buccal, upper occlusal and lower occlusal views were taken for each patient (Kalpana *et al.*, 2018). A total of 100 intraoral images (10 patients) taken from DSLR camera and another 100 intraoral images (10 patients) from MP camera.

Camera operator

All the intraoral photos were taken by one operator (specialist orthodontist) using both DSLR and MP on 20 patients. This was done to eliminate confounding factors associated with calibration and standardization of multiple operators. The image was focused manually for the DSLR camera while for the I-Phone, the auto focus function was used. All the photos were taken in one clinic, with similar setting to reduce setting-bias involved in taking intraoral photography. The photos were all saved as JPEG files. The camera operator was responsible in processing and arranging them to the normal standard of orthodontics photography. The digital manipulation of the photographs was limited to cropping and rotational correction for neatness.

Consent

All 20 patients consented to the intraoral photography.

Double-blinded procedures

Only the camera operator knew about the images and the source of camera. The photos were re-labelled to be Patient 1 to 20 (100 images in total) with patients' details were kept confidential and the information of the source of cameras was kept blinded from the researcher and the assessors. The photos were then uploaded in the I-Pad (8th Generation) and was handed over to the primary investigator. The primary investigator and the assessors were blinded to which of the sets of photographs were taken with DSLR or Mobile Phone. The camera operator only released the information once all the data has been collected and analysed.

Figure 3. Five standard views of orthodontic intraoral photography.

Figure 4. Intraoral orthodontics photographs taken by DSLR camera.

Figure 5. Intraoral orthodontics photographs taken by MP camera.

Assessors

The assessors were five (5) specialist orthodontists from the Kulliyyah of Dentistry (IIUM). All the assessors had no prior information or connection to the photographs and the patients were not known to them. A standard procedural instruction prior to assessment of the photographs was given to the assessors by the primary investigator.

The sets of photographs were shown using a Tablet (I-Pad). A full screen was used for each set. Each photograph set was labelled 1-20 and a score was given for the perceived quality of all photographs.

When responding to the Likert scale, the assessor specified their level of perceived quality for each set of photography without knowing the source of the camera. The score was written by the assessor on the data collection form. The complete form was then handed over to the primary investigator.

Perceived quality scale

A Likert-type rating scale of zero (0), being the poorest quality, to ten (10), being the highest quality, was used in this study.

Reliability test

To examine the intra examiner agreement, a reliability test was done using a test-retest method. The assessors will be requested to redo the assessment as above, on 4 sets of photographs, a few weeks after their initial assessment (T2). The scores for the same sets of photographs, at the initial assessment (T1) were compared.

Statistical analysis

Data was entered into a computer using MS Excel or using statistical software (SPSS, Version 22). Mean and SD were used to describe the average score for both DSLR photographs and MP photographs. Scores were tabulated according to individual assessor as well as a combined total. Reliability scores (T1 and T2) were also tabulated according to assessor as well as a combined total. Data was summarized and described as above and then tested for Normality. As data was Normally distributed. Data was analyzed using an Intraclass Correlation Coefficient to assess reliability and an Independent Sample t-test to assess statistical difference.

Results

Perceived quality of intraoral orthodontic photographs taken with DSLR and mobile phone cameras

Mean and Standard Deviation were used to describe the average score of perceived quality for both DSLR photographs and MP photographs. Table 1 shows scores that were tabulated according to individual assessor as well as the combined total. Figure 6 shows the mean (7.34) and standard deviation (1.08) of DSLR photographs meanwhile Figure 7 shows the mean (7.12) and standard deviation (1.26) of MP photographs.

Table 1. Mean and Standard Deviation of DSLR and MP photographs according to assessor.

Assessor	Score DSLR (Mean, SD)	Score (Mean, SD) MP
Orthodontist 1	6.40 (0.80)	6.20 (1.07)
Orthodontist 2	7.70 (0.78)	7.00 (0.77)
Orthodontist 3	6.60 (0.80)	7.50 (0.67)
Orthodontist 4	8.10 (0.30)	8.10 (0.70)
Orthodontist 5	7.90 (1.13)	6.80 (1.72)
Total	7.34 (1.08)	7.12 (1.26)

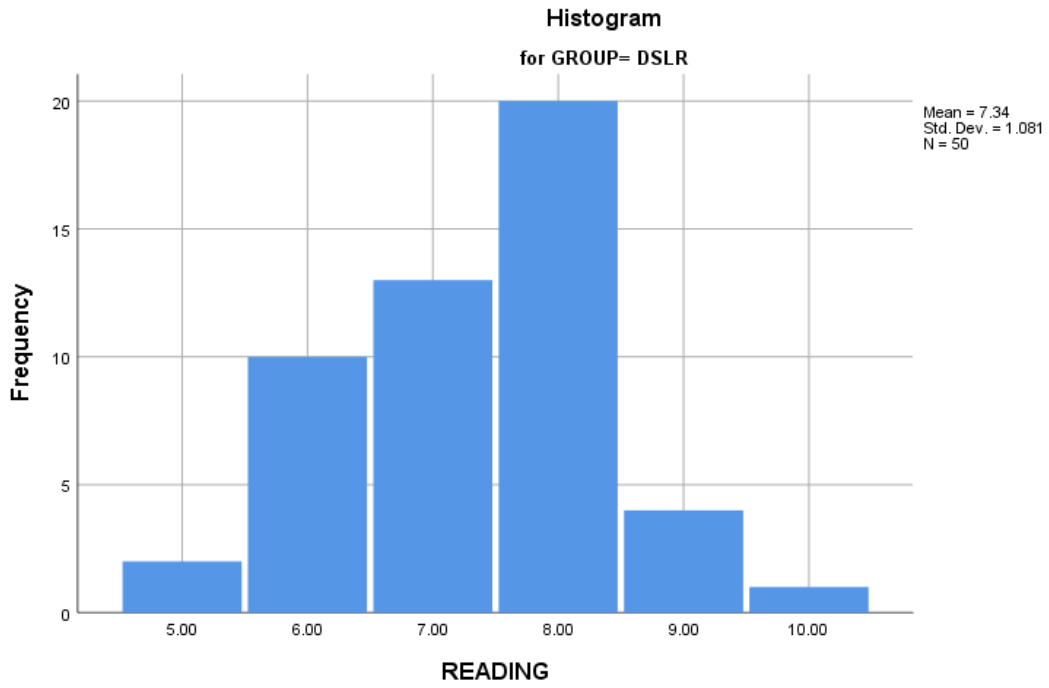

Figure 6. Score (mean, SD) for DSLR photographs

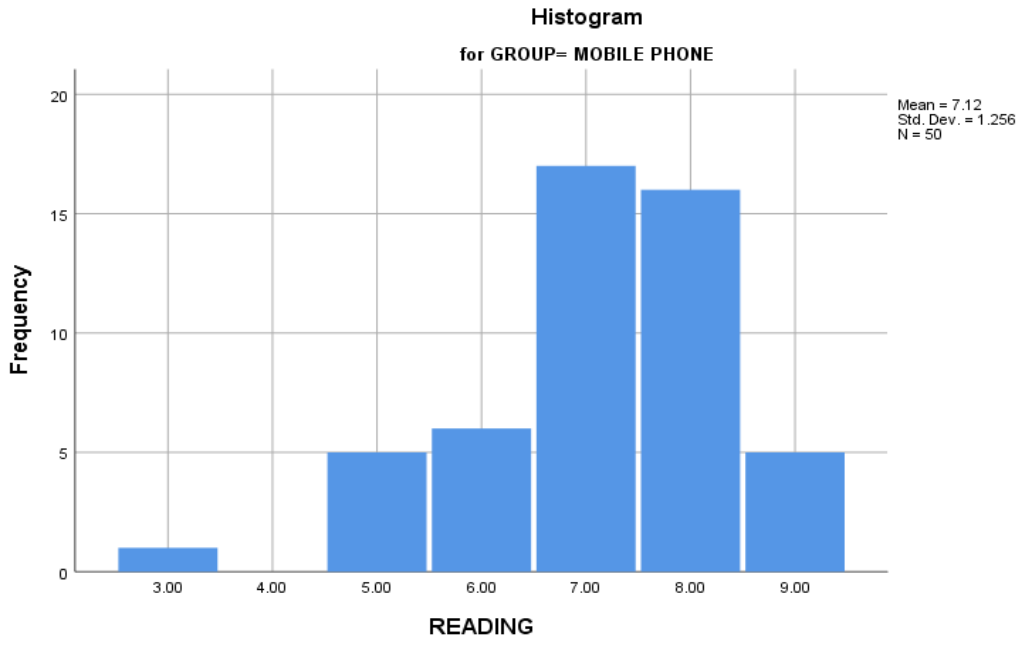

Figure 7. Score (mean, SD) for MP photographs

Comparison of the difference in perception of quality of intraoral orthodontics photography between DSLR camera or mobile phone camera

The comparison of the mean score of the assessment of DSLR and MP photographs is shown in Figure 8. The mean for both DSLR and MP groups demonstrated similar scores, 7.34 and 7.12 respectively.

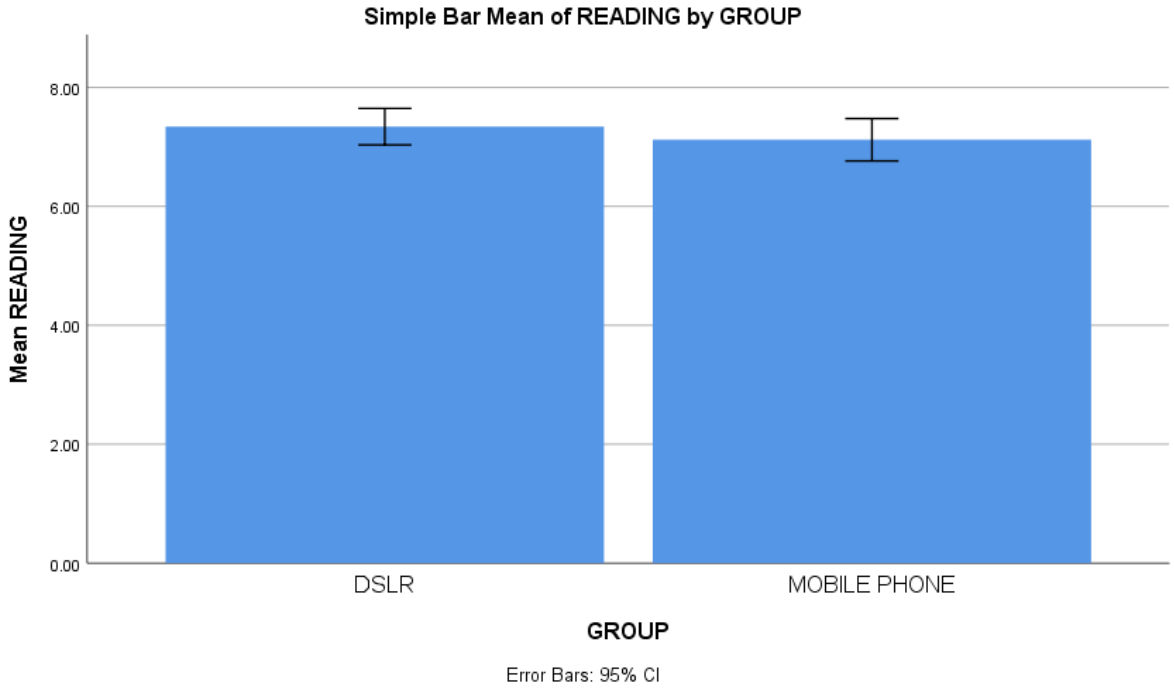

Figure 8. Comparison of the mean score of the assessment of DSLR and MP photographs.

Table 2. Statistical difference between perceived quality of intraoral orthodontic photographs taken with a DSLR camera and photographs taken with a MP camera

Variable	Mean (SD)		t-statistic (df)	p-value
Percieved Quality of Intraoral Orthodontic Photographs	DSLR (N=50)	Mobile Phone (N=50)	0.95 (97)	0.35 (>0.05)
	7.34 (1.08)	7.12 (1.26)		

Table 2 shows the statistical comparison between the DSLR scores and the MP scores. As the data was Normally distributed, an independent samples t-test was used, giving a p-value = 0.35. As such, there was not enough evidence to reject the null hypothesis and it can be concluded that there was no difference between the perceived quality of intraoral orthodontic photographs taken with a DSLR camera and photographs taken with a MP camera.

Reliability of the assessors

The Reliability was evaluated using a test-retest method to ensure good intra examiner

agreement. The five assessors were requested to redo the assessment on 4 sets of photographs, a few weeks after their initial assessment (T2). The scores for the same sets of photographs, at the initial assessment (T1) were compared. The Reliability scores (T1 and T2) were tabulated according to assessor as well as a combined total (Table 3).
The mean, median and skewness was used to establish the normally distribution of the result and Levene's test confirmed the homogeneity of variances. Data were analyzed using Intraclass Correlation Coefficient to assess the reliability (Table 4).

Table 4 shows the obtained Intraclass Correlation Coefficient was 0.549 with 95% confidence interval (ranges between 0.148 and 0.794). Therefore, the level of reliability ranged from fair to good reliability.

Table 3. Reliability scores (T1 and T2) according to assessor

Assessor	Score T1 (Mean, SD)	Score T2 (Mean,SD)
Orthodontist 1	6.00 (1.00)	5.00 (0.71)
Orthodontist 2	7.50 (0.50)	8.50 (0.87)
Orthodontist 3	7.80 (0.43)	7.30 (0.83)
Orthodontist 4	8.00 (0.71)	7.80 (0.43)
Orthodontist 5	7.50 (0.87)	7.50 (0.50)

Table 4. Reliability analysis using Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.549[a]	.148	.794	3.350	19	19	.006
Average Measures	.709[c]	.258	.885	3.350	19	19	.006

Discussion

This study aimed to compare whether there was any difference, in the perception of quality of intraoral orthodontic photographs, taken with a DSLR camera and a MP camera. The results shows that there was no difference between the two. The outcome of this study supported the result from the previous study by Prasad & Sivakumar (2020).

Clinicians who wish or need to take intraoral photographs can perhaps take heart from the findings of this study. The result offers further reassurance for clinicians to use a MP

camera for intraoral photography, especially in orthodontics. This is due to the fact that MP are more practical. MP are also lighter, and easier to use. Dental surgeons are not specifically trained in professional photography, hence, many of them may not be interested in learning and owning an expensive DSLR camera and all the specific accessory equipment necessary when wanting to take good intraoral photographs. This is essentially the opinion given by Samawi (2017).

On the other hand, every dental surgeon or clinician would own a MP, probably at least a mid-range model with very acceptable camera specifications. Learning and using a MP is a skill that would have already been learnt prior to entering Dental School. Therefore, using a MP camera for intraoral photography would probably not be such a learning-curve as it would be when learning how to use a DSLR camera. Recommendations on MP camera set-up for orthodontic photography is already in the literature as in an article by Shahrul *et. al.* (2022).

Thus, the ability to use a MP to obtain good quality intraoral orthodontic photographs without a steep investment in time, effort and money would probably be welcomed by most clinicians. Maintenance and service would probably be easier too due to their ubiquitous presence in society.

This study has a number of limitations and possibilities for improvement in future studies. As the aim of the study was to test perception, which varies between people, a larger sample and a wider pool of assessors would probably increase the strength of the study. Another possible improvement would be to standardize the photographs taken from the same patients with different cameras. This would eliminate another confounding factor hence enable a better comparison between the cameras.

In this study, only one type of mobile phone camera which is the I-Phone 11 was used to compare the quality image of intraoral orthodontics photographs with the gold standard camera which was the Nikon DSLR camera. The Selfie Ring Light used as the lighting component in this study is basic. It served the purpose of illuminating the intraoral area without shadowing. An extra lighting component that achieves this would still be needed with any MP. Further refinement of the lighting technology, for example the addition of a diffuser and more control of the lighting intensity, may make the quality of photographs even better.

Further research can be suggested such as repeating the study using other types of phones, lighting components and accessories, in different clinics. All these further studies may be useful to validate the findings of this study. Photographs obtained from multiple clinics would also possibly improve the generalizability of the results as the sample would be obtained from many alternate real-world clinical environments.

Conclusion

This study showed that the perceived quality of intraoral photographs taken with a DSLR camera, and a mobile phone camera were similarly good. There was also no statistical difference between the perceived quality of either of the two groups of photographs.

Clinical significance

The result gives orthodontic clinicians more confidence to use mobile phones to take intraoral photographs for general clinical purposes especially in orthodontics. This might be because mobile phones are more accessible and more practical compared to DSLR cameras, which are more expensive, heavier, and rather more cumbersome to use.

Acknowledgement

The authors extend their appreciation to IIUM Orthodontists for their participation in this study and to Asst. Prof. Dr Mohd Shafiq Mohd Ibrahim for his advice on the statistics.

References

Desai, V., Bumb, D. (2013). Digital dental photography: a contemporary revolution. *International Journal of Clinical Pediatric Dentistry*. 6(3):193-196.

Hardan, L. (2020). *Protocols for mobile dental photography with auxiliary lighting*. Quintessence Publishing.

Kalpana, D., Rao, S.J., Joseph, J.K., Kurapati, S.K.R. (2018). Digital dental photography. *Indian Journal of Dental Research*, 29,507-512.

Lee, S., Kim, B., Lee, J. and Sasian, J., (2014). Accurate determination of distortion for smartphone cameras. *Applied Optics*, 53 (29), H1–H6.

Liu, M., Zhang, J.D., Ye, H.Q., Zhao, Y.J., Zhao, X.B., Zhao, W.Y., *et al.* (2020). Application and exploration of Smile Lite MDP portable photography system in aesthetic photography of anterior teeth. *Journal of Peking University (Health Sciences)*, 52(1),187-192.

Majumder, S. and Deen, M.J. (2019). Smartphone sensors for health monitoring and diagnosis. Sensors, 19 (9), 2164.

Moussa, C., Hardan, L., Kassis, C., Bourgi, R., Devoto, W., Jorquera, G., *et al.* (2021). Accuracy of dental photography: professional vs. smartphone's camera. *BioMed Research International*, 2021, 3910291V.

Prasad, A.S., Sivakumar, A. (2020). Smartphone vs DSLR dental photography among orthodontists. *Indian Journal of Public Health Research & Development*, 11 (6).

Samawi, S. (2012). Clinical digital photography in orthodontics: professional photographic records in daily practice. *Jordan Dental Journal*, 18 (1).

Samawi, S. (2017). There's something about MDP (mobile dental photography). Retrieved from https://theorthodonticnotefile.blog/2017/08/10/theres-something-about-mdp-mobile-dental-photography/

Shahrul, A. I., Shukor, N., & Norman, N. H. (2022). Technique for orthodontic clinical photographs using a smartphone. *International Journal of Dentistry*, 2022, 2811684.