International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(RESEARCH ARTICLE)

Check for updates

Reliability of non-polarized versus polarized digital photographs for evaluation of gingival redness

Fayrouz Sayed Saber [1,*], Manal Ahmed Al Sayed [2], Ola Moustafa Omar [2] and Omar HMS Moustafa [3]

[1] *Department of Paediatric Dentistry and Dental Public Health, School of Dentistry, Newgiza University, Egypt.*
[2] *Department of Paediatric Dentistry and Dental Public Health, Faculty of Dentistry, Cairo University, Egypt.*
[3] *Department of Conservative Dentistry, Faculty of Dentistry, Cairo University, Egypt.*

International Journal of Science and Research Archive, 2024, 11(02), 549–557

Publication history: Received on 05 February 2024; revised on 16 March 2024; accepted on 19 March 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.11.2.0453

Abstract

Introduction: The reported prevalence of gingivitis in various developed countries is considered high. This rate escalates with the increase in age, especially around puberty which affects their oral health related quality of life. The consequences of periodontal diseases observed in adults mostly had their inception earlier in life. Gingival conditions were found to be worse than caries among adolescents and were not taken seriously compared to caries.

Aim: Comparison between the gingival redness in group of Egyptian children as evaluated using analyzed polarized versus non-polarized digital photographs.

Subjects and methods: 47 Egyptian participants aged 11-14 years-old from Newgiza University outpatients' clinic agreed to participate were recruited and agreed to participate in the study. Gingival redness was evaluated using analyzed digital photographs with and without cross polarizing filter then analyzed via Adobe Photoshop Creative Cloud (CC) 2021 software. Comparison between non-polarized and polarized photos was performed using independent t-test.

Results: The study showed that non-polarized photos were significantly higher in number of red pixels than polarized photos as $P < 0.05$. Reliability between two different digital photographic techniques was performed using Cronbach alpha (α), which revealed strong agreement between polarized and non-polarized digital photographic evaluation.

Conclusion: Digital photography can be used in evaluation of gingival redness with or without cross polarizing filter.

Keywords: Gingival redness; Digital dental photography; Cross polarizing filter; Adobe Photoshop Creative Cloud (CC) 2021

1. Introduction

Developing countries tend to complain more from periodontal diseases compared to developed countries on account of the decreased efficiency of awareness and lack of proper oral hygiene practices. In addition to that, the impact on oral health periodontal diseases have been reported to affect general health as well. Multiple studies linked periodontal disease to increased incidence of major systemic diseases such as cardiovascular diseases, rheumatoid arthritis and possible complications of pregnancy, respiratory diseases, and kidney diseases [1].

In 2019 a study was conducted in Egypt due to the limitation of data regarding the prevalence of periodontal diseases and their association to multiple risk factors. The study aimed to assess the prevalence and the severity of periodontal

* Corresponding author: Fayrouz Saber

disease and whether it was correlated with different risk factors and it concluded that 58.9% of participants had calculus deposits [2].

Gingival diseases that affect children are multiple and might progress to jeopardize the periodontium of the adult. The consequences of periodontal diseases observed in adults mostly had their inception earlier in life. Dental professionals have a serious role in the early recognition and diagnosis of gingival and periodontal diseases to optimize treatment outcomes [3].

Puberty gingivitis is defined as "the considerable increase of gingival inflammation without increased levels of plaque accumulation occurring in children at puberty". The cytoplasm of gingival cells contains high affinity, low-capacity receptors for both estrogens and testosterone. Estrogen receptors are found in the epithelium's basal and spinous layers, in fibroblasts, and in the connective tissue endothelial cells of small vessels. Accordingly, the gingiva appears to be a target organ for many steroid hormones. The relation between the prevalence of gingival inflammation and the amount of circulation sex hormones is ascertained by the fact that gingivitis was observed to spike earlier in females between 11-14 years old than males almost the same age [4].

Chrysanthakopoulos 2016 conducted a study targeting the adolescents in Greece to assess the prevalence of gingivitis and investigate the potential associations among gingivitis with socioeconomic, demographic variables and oral hygiene habits. The study concluded that gingivitis was associated with the following factors: male gender, lower educational, income parental level, inadequate oral hygiene, presence of dental plaque and smoking. The prevalence of this condition in the study sample was 72.8% [5].

A study was conducted aiming to analyze the oral health status of adolescents in Shandong province, including dental caries and gingivitis, and the relevant risk indicators. Caries and gingival status were assessed in adolescents aged 12-15-years following the World Health Organization diagnostic criteria. It was concluded that gingival conditions were worse than caries among adolescents and were not taken seriously compared to caries. They also reported that, gingivitis was associated with brushing habits, while caries was associated with dental visits and toothaches. Therefore, they recommended prevention-oriented dental visits and oral hygiene program trainings to enhance the oral health status [6].

Digital imaging in oral care started with efforts focused on quantifying dental plaque and then tooth color measurement and eventually it reached the gingival health assessments. The development of the digital camera together with image analysis software yielded the first attempts to develop an imaging system able to capture pictures of disclosed plaque and the consequent measurement of plaque coverage [7].

At first it utilized a red coat-disclosing agent that did not enable the analysis software to differ between plaque on the teeth, gingival plaque and gingiva due to the close red color of the three elements. Photographic methods were developed to assess gingival overgrowth. Standardized photographic views can be evaluated against a reference set of photographs that define various degrees of gingival overgrowth [8].

Smith et al. 2008 showed that digital imaging was proven to have excellent reliability for both intra- and inter-examiner measurements. It was concluded that digital photography technique proved a reliable method for investigating changes in gingival redness [9].

A study was held in 2002 that aimed to determine the efficiency of a computer aided system, including a digital camera and computer analysis. Digital images of frontal views of maxillary incisors were taken for the participants and then introduced to a computer-assisted analysis to determine the degree of redness (colorimetric assessment) and swelling (morphometric assessment) and the results were compared with the visual assessment of the Papillary, Marginal, attached index (PMA) gingival score. The study reported that the comparison of the highly scored image samples and the lower scored images were strongly corelated with the visual assessment codes. These preliminary findings suggested that the developed computer-assisted image analysis system showed promise for assessing gingival inflammation via an automated method [10].

Quantitative analysis of gingival swelling and color characteristics of gingiva was investigated using digital imaging before and after treatment of individual patients. Gingival changes were evaluated by assessing redness and tooth surface area visible between the level of the inter-proximal papillae and the gingival margin. Serif photo pluse-6 software was used in calibration and analysis of image for gingival redness. The histogram option in the Serif photo pluse-6 software was used, which gave the mean, standard deviation, and pixels of the previously mentioned gingival area [11].

The above study concluded that regarding the clinical significance, this method helped in providing pictorial data confirmed with the objective data, which matched the clinical changes in color and size of the gingiva, which otherwise usually would be recorded using the standard index method by giving suitable scores in which there was a chance of subjective error due to giving higher or lower score. Therefore, this method helped in motivating the patients for regular follow-ups [11].

In 2016 a study was performed that aimed to investigate and validate the quantitative abilities that the digital imaging technique can calculate in experimental gingivitis conditions before and after clinical intervention. Digital Gingivitis Image Analysis (DGIA) provided an objective, easy-to-use method of evaluating gingival inflammation.

Digital gingivitis image analysis was positively associated with clinical parameters in an experimental gingivitis model. The technique was considered appropriate for large-scale population studies to determine severity and prevalence of gingivitis. The photographic method proved to be highly acceptable among patients. The technique was simple and matched well with clinical scores [12].

Prabhu et al., performed a study in 2017 aiming to evaluate the gingival status after scaling and root planning. They used Adobe software to analyze the digital photographs taken to assess the gingival redness and swelling in 20 adult patients. It was reported by the study that the software and the method of recording were accurate, simple, and objective [13].

“Polar eyes” is a cross-polarization filter that makes it easy to eliminate unwanted reflections on the teeth that are caused by the flash. These specular highlights can obscure details in the teeth and cause problems when communicating with the lab. The polar eyes filter also makes it easier to monitor and document demineralization and decalcification white spot lesions (WSLs). When used with postprocessing calibration using a gray reference card, may lead to an accurate color quantification, regardless of the lighting conditions [14].

To our knowledge, there is scarce evidence regarding the use of cross polarizing filter used to evaluate gingival status. Therefore, this study aims to compare between the gingival redness in group of Egyptian children as evaluated using polarized versus non-polarized digital photographs.

2. Material and Methods

2.1. Ethical approval

Methodology of this study was previously revised and approved by the ethics research committee of Faculty of Dentistry, Cairo University.

2.2. Consent

Prior to implementation, the aim of the study was explained to the mothers/ fathers and written informed consent was obtained. The child’s assent was verbally obtained prior to the photographing session.

2.3. Eligibility criteria

2.3.1. Inclusion criteria

- Children aged from 11-14 years old.
- No reported systemic disease
- No administration of antibiotics in the last month
- No fixed or removable appliance

2.3.2. Exclusion criteria:

- Patient refused to participate in the study.

2.4. Study settings

This study took place in the classrooms of School of Dentistry New Giza University, where the following where done:

The participants assents were taken verbally and were reassured that the photographs will only be used for this research purposes and will not be used or uploaded in any media platform. The participants were seated in the same

socially distanced manner and were allowed to socialize without leaving their seats or taking off their masks unless they were being photographed. The camera was set and standardized. They were called one by one to the photographing area where they were allowed to take off their masks. The dental photographer used his gloved hands to place the cheek retractor then took off the gloves and photographed the participant two digital photographs one with and another without the Polar eye cross-polarizing filter.

2.5. Tools of assessment

Redness: Digital photographic evaluation for redness of the gingiva was analyzed using Adobe Photoshop following what was previously implemented by [13]. The used version was the Adobe Photoshop Creative Cloud (CC) 2021 which is the most recent version of the software.

2.6. Photograph Capturing

Digital photographs were taken by positioning the patient in the frontal head position and using the following camera settings for standardization:

- Nikon digital camera D7200
- Prime lens Nicor with set focal length of 105.
- Twin flashes R1 C1
- Nude 1:4
- Polar eyes cross polarizing filter 1:1
- Photo med twin flash bracket
- Shutter 1:250
- Magnification ratio 1:3

To standardize the distance, the magnification ratio was set to 1:3 and photographs were set on a specific focal length in addition to the previously mentioned Camera settings. This way the photograph can only be focused on a standardized distance and a fixed magnification [15]. Figures (1-2) indicate an example of a participant's digital photographs with and without the polar eyes cross polarizing filter 1:1.

2.7. Photograph Analysis

Photograph analysis for gingival redness was carried out using Adobe Photoshop CC. The histogram option in the Adobe Photoshop software was selected, which gave the mean, standard deviation, median, and percentile of red pixels related to the selected gingival area. The method is highly reliable, easy to perform after initial training and provides an additional tool for assessing gingival health individually on a patient level or in research like in a clinical trial (Smith et al., 2008). Figures (3-4) indicate the analyzed digital photographs with and without the polar eyes cross polarizing filter 1:1.

Steps were implemented as follows:

- Right click on the photograph and select open with Adobe Photoshop CC (raw file type of the photograph)
- Once Photograph opened from tools on the left the cropping option was selected to crop the anterior sextant from the distal interdental papillae on both sides and the level of the attached gingiva on both the upper and lower sides, then the enter button was pressed.
- From tools on the left the polygonal lasso tool was selected to trace the gingival margin on the cropped photograph. Once the upper arch is done the button shift was pressed to add the lower arch to the selection.
- The selected gingival area was then copied, and a new layer was selected where the cropped gingival image was pasted.
- The background image was deselected so that only the new layer including the gingiva of the anterior sextant would be analyzed.
- From the icon Window the Histogram option was selected then on the histogram only the red color, and entire image were selected to be analyzed.
- The histogram plotted the mean, standard deviation, median, and percentile of the red pixels number for this cropped section of the photograph.
- The numbers were documented in an excel sheet for each analyzed captured image both polarized, and non-polarized filter photograph [16].

Figure 1 Photograph of Participant X without Polar eyes cross polarizing filter 1:1

Figure 2 Polarized Photograph of Participant X with Polar eyes cross polarizing filter 1:1

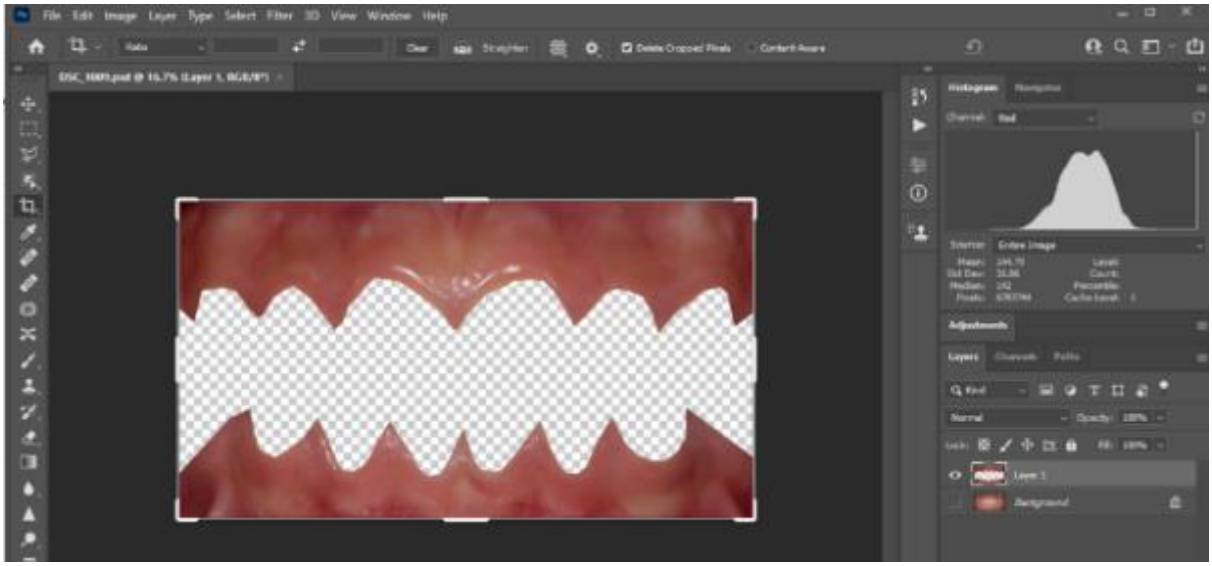

Figure 3 Analyzed Photograph of Participant X with histogram, without Polar eyes cross polarizing filter 1:1

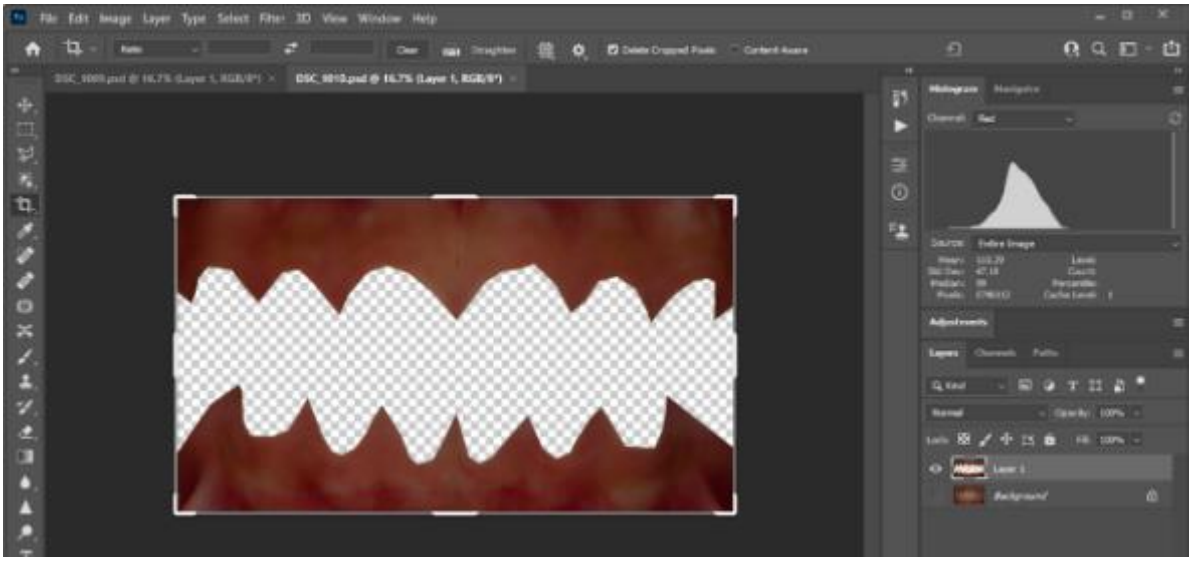

Figure 4 Analyzed Polarized Photograph of Participant X with Polar eyes cross polarizing filter 1:1

3. Results

Statistical analysis for the comparison between polarized and nonpolarized photographs was performed by independent t-test. In non-polarized photos mean ± standard deviation was (176.24 ± 13.54) with 144.79 minimum and 204.28 maximum, while in polarized photos mean ± standard deviation was (128.57 ± 17.16) with 90.99 minimum and 168.76 maximum. Comparison between non-polarized and polarized photos revealed that non-polarized photos were significantly higher in number of red pixels than polarized photos as P <0.05, as presented in table (1) and figure (5).

Table 1 Polarized and non-polarized digital photographic evaluation of gingival status

	N	Min.	Max.	Mean	SD	P value
Non polarized	447.00	144.79	204.28	176.24	13.54	0.0001*
Polarized	47.00	90.99	168.76	128.57	17.16	

N: count Min: minimum Max: maximum SD: standard deviation

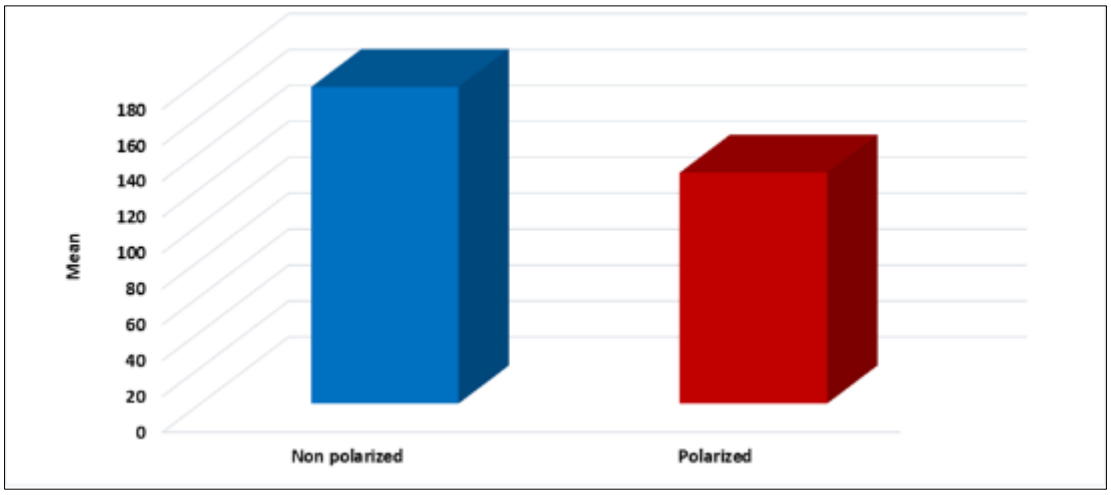

Figure 5 Bar chart represents polarized and non-polarized digital photographic evaluation

Reliability between two different digital photographic techniques was performed using Cronbach alpha (α), which revealed strong agreement between polarized and non-polarized digital photographic evaluation of gingival redness as presented in table (2).

Table 2 Reliability between polarized and non-polarized digital photographs using Cronbach alpha (α)

Cronbach alpha (α)	IOC	Reliability
	0.851	Good

4. Discussion

Gingival status was evaluated in this study in terms of the number of red pixels in digital photographs. As digital imaging was proven to have excellent reliability for both intra- and inter-examiner measurements. It was concluded that digital photography technique proved a reliable method for investigating changes in gingival redness [9].

Each digital photograph was taken twice, once with and another time without Polar eyes cross polarizing filter. The difference between them is that with filtered (polarized photograph) there was less glare or reflection of light on the pictures and therefore producing a photograph that allows for more objective assessment of color parameters. Because of the two-stage filtering, there were no reflections to distract from the natural colors of the photo and consequently it was easier to visualize this matte photograph with its polychromatic feature [17].

Photographs were analyzed and interpreted using Adobe Photoshop CC 2021. The histogram option in the Adobe Photoshop software was selected, which gave the mean, standard deviation, median, and percentile of red pixels related to the selected gingival area. This method was selected following Prabhu et al. as they reported that the software and the method of recording were accurate, simple, and objective [13].

Lack of evidence regarding the true color of the gingiva is due to lack of standardized methods for color matching and absence of gingival shade guides, gingival color is subjectively visually observed [18]. Visual observation technique is multifactorial and can be influenced by gender and or observer training [19]. Therefore, visual observation might be less reliable than the digital method [20].

While testing the reliability between the two different digital photographic techniques there was a strong agreement between polarized and non-polarized digital photographic evaluation before and after oral health education. Cronbach alpha (α) was equal to (0.851) indicating good agreement between both techniques of photography in assessing gingival redness. Which means that using a cross polarizing filter or not may not affect the reliability of the digital photographic assessment when evaluating gingival redness and analyzing it using Adobe photoshop. The results are in agreement with that of Zahid et al, as they suggest that both polarized and non-polarized imaging may be used to analyze changes in gingival pigmentation [21].

In our opinion, this could be explained by the amount of glare produced by the flash during digital photography, which in the setting of the current study did not reduce or alter the number of red pixels in an amount that affects the reliability of the assessment. This in in alignment with other studies that suggests that the use of cross polarizing filter is one of the most consistent techniques for tooth color assessment, as it helps reduce undesirable reflections and diffuse light produced by the flash [22].

Non-polarized images with standard parameters can replicate gingival color accurately. However, many factors have to be considered, including specular reflection, image resolution, light source, white balance, and light glare [14].

Another study comes in disagreement with our results claiming that the color-matching results of tested digital photography techniques with and without cross-polarization were unacceptable. However, the study was evaluating color matching for shade selection and not gingival redness [23].

5. Conclusion

Regarding the use of digital photography, there is a reliable agreement between polarized and non-polarized digital photographs in evaluation of gingival redness.

Compliance with ethical standards

Acknowledgments

The authors wish to thank School of Dentistry Newgiza University who has contributed to the success of this research work.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of ethical approval

Methodology of this study was previously revised and approved by the ethics research committee of Faculty of Dentistry, Cairo University.

Statement of informed consent

The aim of the study was explained to the parents and written informed consent was obtained. The child's assent was verbally obtained prior to the photographing session. and they were ensured that the photographs are for research purposes and will not be posted on any social media platform.

References

[1] Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. Int J Health Sci (Qassim). 2017; 11(2): 72–80.

[2] Abbass MMS, Rady D, Radwan IA et al. Prevalence of periodontal diseases and its correlation with different risk among an adult Egyptian population: a cross-sectional study. 2019; 8:1740.

[3] Clerehugh V, Kindelan S. Guidelines for periodontal screening and management of children and adolescents under 18 years of age. British society of Periodontology and British society of Paediatric dentistry. 2012

[4] Nakagawa S, Fujii H, Machida Y, Okuda K. A longitudinal study from prepuberty to puberty of gingivitis. Jclin Periodontol. 1994; 21:658-65.

[5] Chrysanthakopoulos NA. Prevalence of gingivitis and associated factors in 13–16-year-old adolescents in Greece', European Journal of General Dentistry. 2016; 5:58–64.

[6] Zhang, M., Lan, J., Zhang, T. et al. Oral health and caries/gingivitis-associated factors of adolescents aged 12–15 in Shandong province, China: a cross-sectional Oral Health Survey. BMC Oral Health. 2021; 21, 288.

[7] Soder PO, Jin LJ, Soder B. Computerized planimetric method for clinical plaque measurement. Scand J Dent Res. 1993; 101:21–25.

[8] Hefti, A. F., Eshenaur, A. E., Hassell, T. M. & Stone, C. Gingival overgrowth in cyclosporine A treated multiple sclerosis patients. Journal of Periodontology. 1994; 65, 744–749.

[9] Smith RN, Lath DL, Rawlinson A et al. Gingival inflammation assessment by image analysis: measurement and validation. Int J Dent Hygiene. 2008; 6; 137–142.

[10] Iiyama M, Saito K, Horiuchi H, Shimauchi H, Marshall RI, Bartold PM. Applicability of a computer-assisted image analysis system for the evaluation of gingival status in subjects from Asian and Caucasian backgrounds. J Int Acad Periodontol. 2002; Jan;4(1):26-32. PMID: 12670083.

[11] Seshan, Hema & Shwetha, M. Gingival inflammation assessment: Image analysis', Journal of Indian Society of Periodontology. 2012; 16. 231-4.

[12] Aranguren LE. A clinical trial to investigate digital gingivitis image analysis method and examiner-based grading in assessing experimental gingivitis. Master thesis, digitalcommons.uconn.edu. 2016.

[13] Prabhu R., Wagle SV., Agrawal AA., Sankhe R., Bhartiya G., Chaudhari D. Application of Computer Software for Objective Evaluation of Changes in Size and Colour of Gingiva after Scaling and Root Planning. International Journal of Contemporary Medical Research. 2017; 4:6.

[14] Farah RI, Almershed AS, Albahli BF, Al-Haj Ali SN. Effect of ambient lighting conditions on tooth color quantification in cross-polarized dental photography: a clinical study. J Prosthet Dent. 2022; 128(4):776–783.

[15] Ahmad I. Clinical Dental Photography. In: Pasquali P. (eds) Photography in Clinical Medicine'. Springer, Cham. 2020.

[16] Adobe Photoshop Creative Cloud, (n.d.) Learn and support. https://www.adobe.com/mena_en/creativecloud/photography.html.

[17] Duarte S Jr. ed. Quintessence of Dental Technology. Hanover Park, IL. Quintessence Publishing Co.14. 2014.

[18] Gomez-Polo C, Montero J, Gomez-Polo M, Martin Casado AM. Clinical study on natural gingival color. Odontology. 2019;107(1):80–89.

[19] Clary JA, Ontiveros JC, Cron SG, Paravina RD. Influence of light source, polarization, education, and training on shade matching quality. J Prosthet Dent. 2016; 116(1):91–97.

[20] Preethi Suganya S, Manimaran P, Saisadan D, et al. Spectrophotometric Evaluation of Shade Selection with Digital and Visual Methods. J Pharm Bioallied Sci. 2020; 12(5): S319–S323.

[21] Zahid TM, Natto ZS. Validity and Reliability of Polarized vs Non-Polarized Digital Images for Measuring Gingival Melanin Pigmentation. Clin Cosmet Investig Dent. 2023; 15:189-197.

[22] Sampaio CS, Atria PJ, Hirata R, Jorquera G. Variability of color matching with different digital photography techniques and a gray reference card. J Prosthet Dent. 2019; 21(2):333–339.

[23] Yilmaz, Burak & Ömür, Do & Dds, Dede & Diker, Emre & Fonseca, Manrique & Dds, Fonseca & Johnston, William & Johnston, Michael & Ahmet, & Küçükekenci, Ahmet. Effect of cross-polarization filters on the trueness of colors obtained with a single-lens reflex camera, macro lens, and a ring flash. J Esthet Restor Dent. 2023 Sep;35(6):878-885.