



COMPARISON OF CHARACTERISTICS OF TWO DIFFERENT COMPOSITE RESINS BY CLINICAL ASSESSMENT AND DIGITAL PHOTOGRAPHY - A RANDOMISED CONTROLLED CLINICAL TRIAL

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Abstract: Objective: Digital photography is used in documenting, evaluation of restorations, storage of images for future references and also other multiple uses. Direct clinical examination is the fastest, cheapest and most commonly used method of assessment. The purpose of this study was to evaluate the characteristics of two different composites by clinical and digital modes of assessment. **Material and Methods:** Three parameters, including color, occlusal marginal adaptation, and roughness were assessed in 30 Class I Light cure restorations using two different composites, in adults using the USPHS/Ryge criteria. All the parameters were clinically and photographically assessed. Due to the non-uniform distribution of data, Independent Sample Mann-Whitney U Test was done. To study the agreement between clinical and photographic methods of assessment Kappa statistics were used. **Result:** There was no significant difference in the colour, marginal adaptation and surface roughness between the two composites. However, Ivoclar Te-Econom Plus was better than Dentsply Ceram X. Also the photographic method was better for assessing colour and marginal adaptation. Whereas, the clinical assessment was better for surface roughness. **Conclusion:** Within the limitations of the study, there was no significant difference in colour, marginal adaptation and surface roughness between the two composites used. Further studies with larger sample sizes are needed to warrant the results of this study. Overall, the digital photographic method provides more information about the quality of restoration compared to clinical assessment.

Keywords: clinical assessment, dental restoration, digital photography, disease, health, photographic assessment, resin composite

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INTRODUCTION

Globally, it is estimated that 2 billion people suffer from dental caries. Despite being entirely preventable, oral diseases are a significant health burden for many nations and have a lifetime impact on people, causing pain, discomfort and disability. The cost of treating oral health issues usually excludes them from universal health care. Dental caries is a multifactorial diseases in which localised demineralization of tooth surfaces, which

may ultimately lead to cavity development, is caused by the fermentation of dietary carbohydrates by bacteria from the biofilm (dental plaque). Hence, resin composites are frequently utilised to restore dental caries.

Digital photography is significant on multiple levels and has become synonymous with modern dentistry. Its use in dental practice is easy, quick, and particularly effective for documentation of procedures, patient counselling, and clinical research, yielding many benefits to dentists and patients. (Joseph *et al.*, 2018) The simplicity of documentation and preservation of clinical photographs of specific clinical cases has been substantially influenced by digital intraoral photography. As a result, its application in dentistry is steadily expanding. (Smith, 2002; Christensen, 2005; Ahmad, 2009; Schropp, 2009) Digital photography can be used to evaluate restorations (Smales, 1983), control of tooth whitening (Bengel, 2003), and colour selection of composite resins. It's also been utilised to record and analyse orthodontic therapy (Christensen, 2005) as well as to assess the colour of healthy gingiva. (Denissen, Kuijkens and ?ozic, 2007) Other uses include patient education, dento-legal documentation, communication, marketing and portfolios. (Paredes, Gandia and Cibrián, 2006)

Clinical examination is quick and inexpensive, and it can evaluate all surfaces of the teeth. Nevertheless, it has several drawbacks, including observer bias and the impacts of visual impairments caused by the examiner's weariness. Also, the accuracy of the study is highly reliant on the patients' cooperation. (Golkari *et al.*, 2011)

To diagnose dental restorations, a clinical examination is required.(Bottenberg *et al.*, 2016) The first study comparing clinical examination and photographic evaluation of dental restorations using the United States Public Health Service (USPHS)/ Ryge modified criteria found that a photographic method is a useful tool in analysing restorations and that it provides more information than the clinical exam even without image modifications such as enlargement or corrections.(Moncada *et al.*, 2014) Other studies support these findings, confirming that digital pictures reveal greater errors in dental restorations.(Smales and Joseph Creaven, 1985; Chen *et al.*, 2013; Signori *et al.*, 2018) Criteria have been developed to guide restoration evaluations to avoid bias and build consistent test methods.(Opdam *et al.*, 2018) Although the World Dental Federation (FDI) standards are the most recent and sensitive clinical criteria for evaluating dental restorations, they are less often employed than the modified USPHS criteria.(Marquillier *et al.*, 2018)

Previously our team had a rich experience in working on various research projects across multiple disciplines (Kumar *et al.*, 2006; Felicita, Chandrasekar and Shanthasundari, 2012; Krishnan and Lakshmi, 2013; Patturaja, 2016; Sivamurthy and Sundari, 2016; Felicita, 2017; Azeem and Sureshbabu, 2018; Rao and Kumar, 2018; Sekar *et al.*, 2019) Now the growing trend in this area motivated us to pursue this project. Thus, this study aimed to compare two types of posterior resin composite restorations using direct clinical and indirect high-quality digital photographic assessments. The study's null hypothesis was that direct clinical and indirect photographic evaluations of the quality of two resin-based composite restorations showed equivalent outcomes.

MATERIALS AND METHOD

Table 1: Modified Ryge/USPHS Clinical Criteria

Parameters	Alpha	Bravo	Charlie
Colour	The restoration matches in colour and translucency to adjacent tooth structure	The mismatch in colour and translucency is within the acceptable range of tooth colour and translucency	The mismatch is outside the acceptable range of colour and translucency
Marginal Adaptation	Explorer does not catch or has a one-way catch when drawn across the restoration/tooth interface	Explorer falls into a crevice when drawn across the restoration/tooth interface	Dentin or base is exposed along the margin
Surface Roughness	The surface of the restoration has no surface defects	The surface of the restoration has minimal surface defects	The surface of the restoration has severe surface defects

Photographic Method

On the same day as the clinical evaluation, standardised images of each restoration were taken with a digital camera (Nikon-D3500, Tokyo, Japan) equipped with a Macro Lens and ring flash. The photographs were shot in Raw plus JPEG fine quality with a resolution of 12.0 mega-pixels. Manual operation mode, ISO 100, F-18, shutter speed 1/200, and RGB colour space were among the camera's settings.

A skilled clinical photographer took the photographs, which were shot with the patients seated in a dental chair and reclining back to avoid movement during focusing and photography. Retraction of the cheek and lips was provided by an assistant. When necessary, saliva and food bits were removed with air or sterilised gauze. The photos were taken by focusing on the

This study was conducted in permanent teeth of adult patients in the Saveetha Dental College, Chennai. Approval and ethical permission were obtained from the Ethics Committee in Saveetha Dental College. Ethical Clearance number IHEC/SDC/ENDO-2002/21/296. The sample consisted of 30 restorations from patients reporting Clinics of Saveetha Dental College.

CLINICAL EXAMINATION

The goal of the research and the study methods were discussed with the patients upon arrival at the clinic, permission was requested for the photos and a dental exam, and the patient who accepted the study's conditions completed an informed consent form.

The modified US Public Health Service (USHPS)/Ryge criteria were used to assess three parameters in Class I and Class II restorations using two distinct composites in adults, including occlusal marginal adaptation, colour, and roughness. (See Table 1) Adult patients in good hygienic condition with Class I composite restorations in the posterior teeth met the inclusion criteria.

An examiner conducted a direct intraoral clinical examination. At the start of the trial, each restoration was clinically assessed separately for colour, marginal adaptation, and surface roughness. The restorations' quality was assessed using the USPHS/ Ryge criteria, which require the use of an eye without any magnification device, a dental mirror and an explorer, in a well-isolated field, following the instruction to assess each parameter.

Teeth were inspected under the artificial light of the dental unit after drying with the air of a three-way syringe. Plain mirrors and explorers were utilised for the examination.

restorations' centre. To minimise mirror reflection and picture burnout, the camera was set perpendicular to the occlusal surface or tilted no more than 208 degrees to the tooth plane. Each photograph was assessed for acceptability and quality; if either of these factors were lacking, the shot was redone. Images were saved to a Mac iOS device. An examiner independently assessed and scored each photograph using the same criteria used in the clinical method. (See Table 1)

RESULTS

Thirty posterior class I composite restorations in 30 patients (mean age 35 years) were evaluated with clinical and photographic methods for three parameters.

The study looked at three variables: colour, marginal adaptation, and surface roughness for restorations using two composites (Ivoclar Te econom Plus and Dentsply Ceram X). (Table 2) (Table 3) and (Table 4) depict the results of the clinical and photographic assessment of colour matching, marginal adaptation and surface roughness for Ivoclar Te Econom Plus and Dentsply Ceram X Spectra using Modified USPHS/Ryge Criteria.

Table 2: Results of Clinical and Photographic assessment of Colour matching for Ivoclar Te Econom Plus and Dentsply Ceram X Spectra using Modified USPHS/Ryge Criteria

Sr no.	Clinical assessment		Photographic assessment	
	Group 1	Group 2	Group 1	Group 2
1	Charlie	Charlie	Bravo	Charlie
2	Alpha	Bravo	Alpha	Bravo
3	Alpha	Bravo	Alpha	Bravo
4	Alpha	Alpha	Bravo	Charlie
5	Alpha	Alpha	Alpha	Alpha
6	Alpha	Bravo	Bravo	Bravo
7	Alpha	Alpha	Alpha	Alpha
8	Alpha	Alpha	Alpha	Bravo
9	Alpha	Alpha	Alpha	Alpha
10	Alpha	Alpha	Alpha	Alpha
11	Alpha	Alpha	Alpha	Alpha
12	Charlie	Alpha	Charlie	Alpha
13	Charlie	Alpha	Bravo	Alpha
14	Bravo	Alpha	Alpha	Bravo
15	Bravo	Alpha	Bravo	Alpha

Table 3: Results of Clinical and Photographic assessment of Marginal adaptation for Ivoclar Te Econom Plus and Dentsply Ceram X Spectra using Modified USPHS/Ryge Criteria

Sr. No.	Clinical Assessment		Photographic Assessment	
	Group1	Group 2	Group1	Group 2
1	Bravo	Charlie	Charlie	Charlie
2	Alpha	Alpha	Alpha	Charlie
3	Bravo	Bravo	Alpha	Bravo
4	Alpha	Bravo	Charlie	Charlie
5	Bravo	Alpha	Alpha	Alpha
6	Bravo	Bravo	Bravo	Alpha
7	Alpha	Bravo	Bravo	Alpha
8	Bravo	Charlie	Alpha	Alpha
9	Bravo	Alpha	Bravo	Alpha
10	Bravo	Bravo	Alpha	Alpha
11	Alpha	Bravo	Alpha	Alpha
12	Charlie	Alpha	Charlie	Bravo
13	Charlie	Alpha	Bravo	Bravo
14	Alpha	Alpha	Bravo	Bravo
15	Alpha	Alpha	Bravo	Bravo

Table 4: Results of Clinical and Photographic assessment of Surface Roughness for Ivoclar Te Econom Plus and Dentsply Ceram X Spectra using Modified USPHS/Ryge Criteria

Sr. No.	Clinical assessment		Photographic assessment	
	Group1	Group 2	Group 1	Group 2
1	Bravo	Charlie	Charlie	Charlie
2	Alpha	Charlie	Alpha	Charlie
3	Bravo	Charlie	Bravo	Bravo
4	Alpha	Bravo	Charlie	Charlie
5	Bravo	Bravo	Bravo	Alpha
6	Bravo	Bravo	Alpha	Alpha

7	Bravo	Bravo	Alpha	Alpha
8	Bravo	Charlie	Alpha	Bravo
9	Alpha	Alpha	Alpha	Alpha
10	Charlie	Bravo	Alpha	Alpha
11	Alpha	Charlie	Alpha	Alpha
12	Charlie	Bravo	Charlie	Bravo
13	Charlie	Bravo	Bravo	Bravo
14	Alpha	Alpha	Bravo	Bravo
15	Alpha	Bravo	Bravo	Bravo

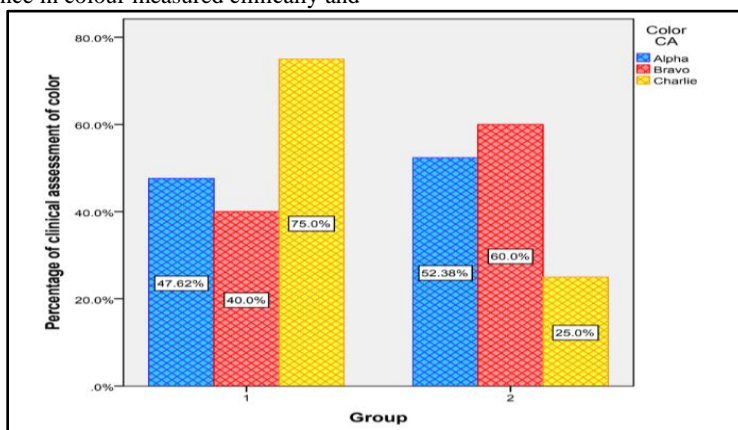
The results of these methods appeared to be more consistent with clinical assessment when the restorations were in permissible condition with one or more faulty parameters (Bravo), but when the restorations were clinically assessed as excellent condition (Alpha) or in cases of severely deficient restorations (Charlie), the outcomes of these methods appeared to be less consistent.

Clinical and photographic evaluations of colour yielded identical results. For both classes of composites, restorations rated as Alpha clinically were often rated as Alpha photographically as well. For both types of composites, there was no significant difference in colour measured clinically and

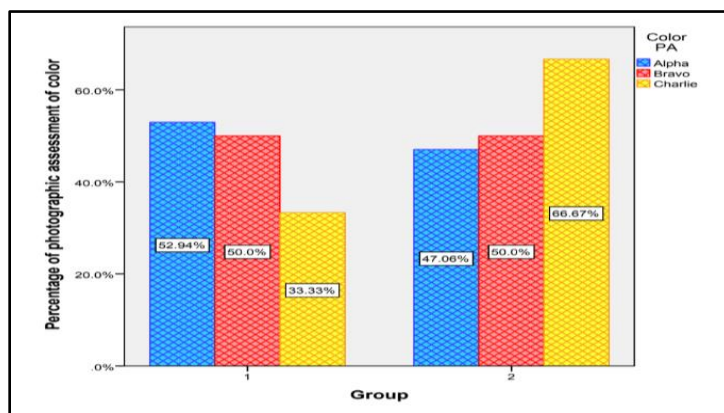
photographically ($p>0.05$).

The evaluation of marginal adaptation showed highly variable results for both groups of composites assessed clinically and photographically. There was no significant difference between marginal adaptation for both groups with either method of assessment ($p>0.05$).

Photographic methods assessed more restorations as acceptable or satisfactory with some defects (Alpha or Bravo) compared to the clinical mode of assessment. More restorations were rated Charlie when clinically evaluated. There was no significant difference between both groups of composites ($p>0.05$).

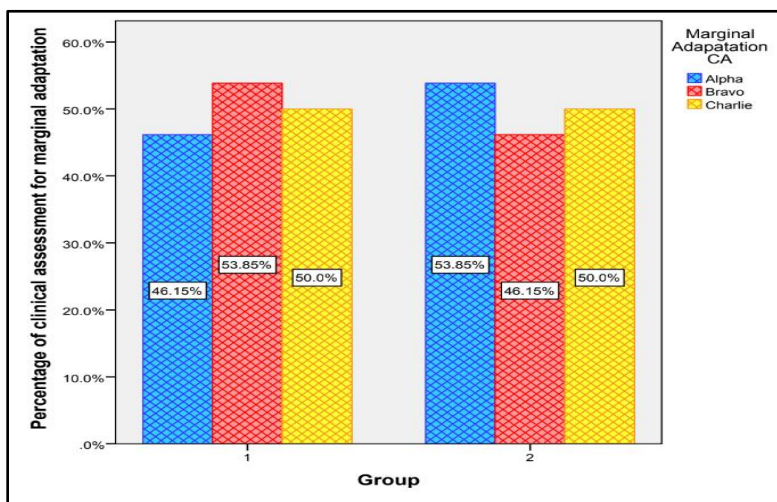


Graph 1: Clinical assessment of colour in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus). Clinically, best colour matching(Alpha) was seen in group 2(52.38%) compared to group 1 (47.62%), mismatch or outside acceptable range colour matching(Charlie) was higher in group 1(75%) as against group 2(25%) and acceptable colour matching (Bravo) was higher in group 2(60%) compared to group 1(40%).

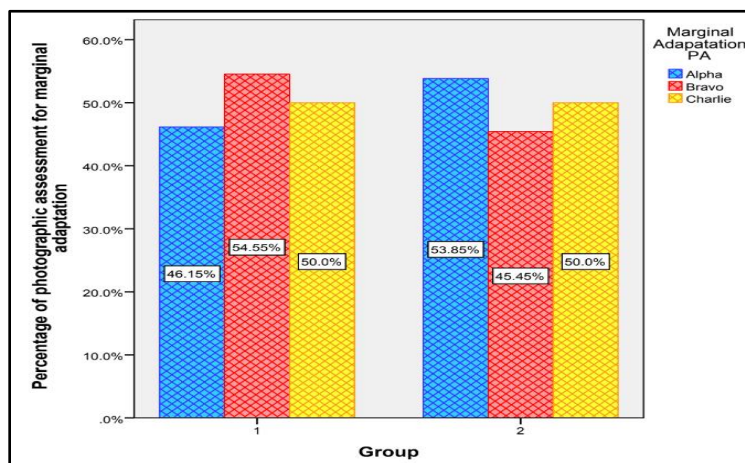


Graph 2: Photographic assessment of colour in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus). In terms of colour matching (Alpha), group 1 (52.94 %) outperformed group 2 (47.06 %). Colour matching was within an acceptable range (Bravo) for 52.94 % of group 1 and 47.06 % of group 2. Group 2 (66.67%)

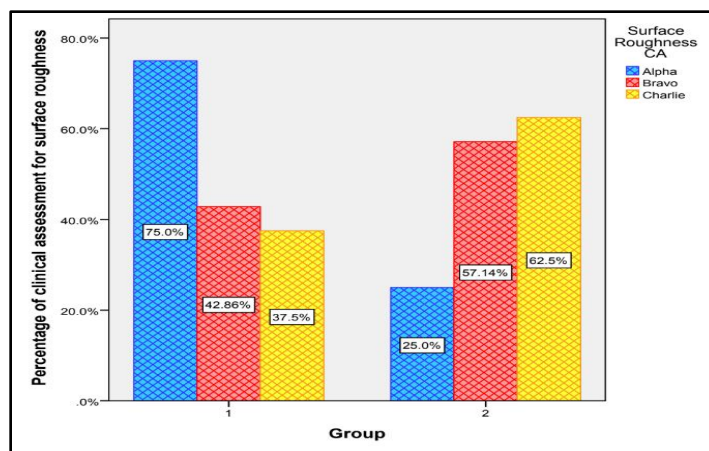
has more mismatch or unacceptable colour matching (Charlie) than Group 1. (33.33 %).



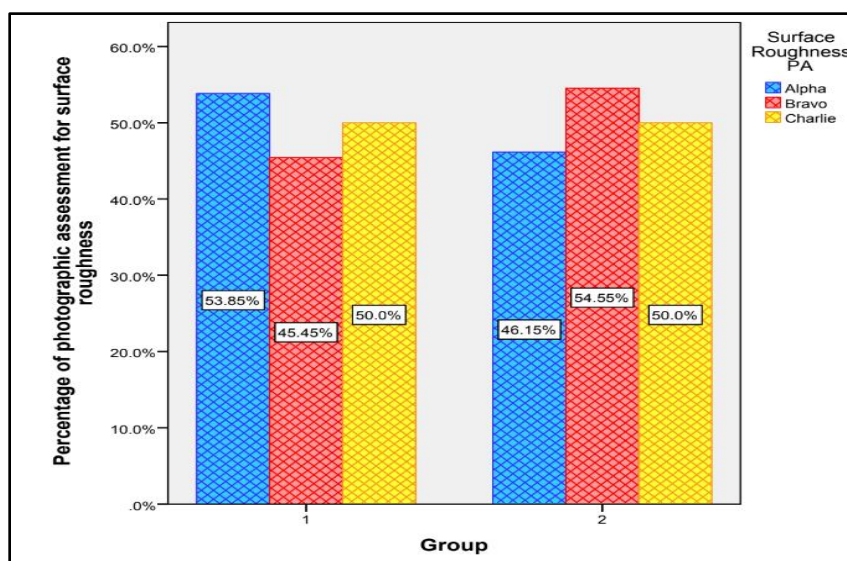
Graph 3: Clinical assessment of marginal adaptation of restorations in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus). Clinically, more restorations in Group 2 (53.85%) had no marginal discrepancies (Alpha) than in Group 1 (46.15 %). When compared to group 1(53.85 %), group 2 (46.15 %) had a higher number of restorations with minor inconsistency in marginal adaptation (Bravo). In both groups, severe marginal discrepancies (Charlie) were observed in an equal number of restorations.



Graph 4: Photographic assessment of marginal adaptation of restorations in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus).Photographically, group 2 (53.4 %) demonstrated better marginal adaptation (Alpha) than group 1(46.15 %). A greater number of restorations in Group 1 (54.55 %) had slight marginal inconsistency (Bravo) than in Group 2 (45.45 %), while an equal number of restorations in both groups had severe marginal discrepancy (Charlie).



Graph 5: Clinical assessment of surface roughness of restorations in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus). Clinically, group 1 had 75% more restorations with no surface defect (Alpha) than group 2 (25 %). Minimal surface defects (Bravo) were higher in group 2 (57.14 %) than in group 1 (42.86 %), and severe surface defects (Charlie) were found in a greater number of restorations in group 2 (62.5 %) than in group 1 (37.5 %).



Graph 6: Photographic assessment of surface roughness of restorations in group 1(Dentsply Ceram X Spectra) and group 2(Ivoclar TE-Econom Plus). Photographically, group 1(53.85%) had a higher percentage of restorations with no surface defects (Alpha) than group 2(46.15 %). A similar number of restorations in both groups have severe defects (Charlie), but more restorations in group 2 (54.55 percent) have minimal surface defects (Bravo) than in group 1 (45.45%).

In this study, 30 class I restorations made by composites from two different companies, namely, Ivoclar Te Econom Plus(hybrid composite) and Dentsply Ceram X Sphere Tec one Universal(nano-ceramic composite), were used to study the colour, marginal adaptation and surface roughness through clinical and photographic modes of assessment. It was found that there was no significant difference between both groups of composites regarding colour, marginal adaptation or surface roughness. The photographic mode of assessment was better than clinical assessment for colour and marginal adaptation, while surface roughness was better assessed clinically. Clinically, Ivoclar TE-Econom Plus showed better colour

matching compared to Dentsply Ceram X Spectra while photographically, Dentsply Ceram X Spectra showed better colour matching. These results were in agreement with findings by Lee et al,2013 and Golkari et al,2011 (Golkari *et al.*, 2011; Chen *et al.*, 2013). Almeida et al,2019 found clinical assessment for colour and translucency to be more reliable than digital assessment.(de Almeida *et al.*, 2021) This discrepancy may be due to differences in the site of the restorations(anterior and posterior) being examined. Also while determining colour, the teeth were exposed to a variety of lighting conditions, including the camera flash during photography and the light source of the dental device in the clinic, both of which could

cause metamerism.(Corcodel *et al.*, 2010)^(Sproull, 1974)

Marginal adaptation is a crucial functional property. It is important to evaluate the tooth–restoration interface to prevent contamination and the development of secondary caries. While evaluating marginal adaptation, the clinical approach allows for probing with an explorer along with the visual inspection. In this study, clinically and photographically, Ivoclar TE-Econom Plus showed better marginal adaptation compared to Dentsply Ceram X Spectra. There was a significant difference between the clinical and photographic modes of assessment. The photographic assessment was better for evaluating marginal adaptation. These findings complied with those of Moncada *et al.*, 2014(Moncada *et al.*, 2014), who state that without photographic evaluation, parameters such as marginal adaptation, roughness, anatomic shape, and staining of margins would have gone unnoticed. However, these results were contradictory to the results found in a study by Almeida *et al.*, 2019(de Almeida *et al.*, 2021), which conclude that overall clinical assessment was superior in assessing marginal adaptation. The photographic digital image might create the impression of restoration continuity, reducing the ability to judge this parameter.

Dentsply Ceram X Spectra in comparison to Ivoclar Te Econom Plus showed lesser surface roughness, both clinically and through photographic assessment. However, it was noted that the clinical method of assessment was better to evaluate surface roughness.

For several years, dental practitioners have known that dental restorations have a short lifespan, which is a serious concern for both patients and doctors. Early diagnosis of localised restoration faults may make it easier to repair rather than replace these restorations, increasing their longevity.(Mjör, Moorhead and Dahl, 2000; Moncada *et al.*, 2015) After finishing dental restorations, using digital images as a means of storing information may assist the clinician in tracking their ageing over time. This approach enables the implementation of proper maintenance steps to extend the life of the restoration.(Moncada *et al.*, 2009; Fernández *et al.*, 2011)

Our institution is passionate about high-quality evidence-based research and has excelled in various fields.(Neelakantan *et al.*, 2011; Jain, Kumar and Manjula, 2014; Lakshmi *et al.*, 2015; Keerthana and Thenmozhi, 2016; Johnson *et al.*, 2019) Use of digital photography as an adjunct to clinical assessment can increase the quality of the restorations, enhance performance by clinicians and increase the longevity of the restoration.

CONCLUSION

Within the limitations of this study, it was found that there was no significant difference between the two composites assessed clinically and photographically for colour, marginal adaptation and surface roughness. However, the photographic mode of assessment was better than clinical for colour and marginal adaptation. While the clinical assessment was better for evaluating surface roughness.

DISCLOSURE

The authors do not have any financial interest in the companies whose materials are included in this article.

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