Available online on 15.03.2023 at ijmspr.com

International Journal of Medical Sciences and Pharma Research

Open Access to Medical Science and Pharma Research

Open Access Research Article

Effects of Oral Hygiene Habits on the Clinical Performance of Tooth-Coloured Posterior Restorations

*Harrison A Omokhua, Mathew A Sede, Joan E Enabulele

Department of Restorative Dentistry, University of Benin, Benin City, Edo state, Nigeria

Article Info:

Article History:

Received 09 Jan 2023
Reviewed 02 February 2023
Accepted 12 February 2023
Published 15 March 2023

Cite this article as:

Omokhua HA, Sede MA, Enabulele JE, Effects of Oral Hygiene Habits on the Clinical Performance of Tooth-Coloured Posterior Restorations , International Journal of Medical Sciences & Pharma Research, 2023; 9(1):1-6

DOI: http://dx.doi.org/10.22270/ijmspr.v9i1.68

*Address for Correspondence:

Dr. Omokhua H A, Department of Restorative Dentistry, University of Benin, Benin City, Edo state

Abstract

Background: The search for a material that will meet the present-day demands for good aesthetics and functionality has continued to generate interest in dental material sciences. Resinous materials, especially composite resins have no doubt been employed in meeting some of these demands. These restorations like the natural teeth are often exposed to the effect of toothbrushing and other oral hygiene practices.

Objective: The study aimed to assess the effects of toothbrushing on the clinical performance of Resin-based Composites in posterior teeth.

Method: This was a prospective study carried out in the conservative clinic of the University of Benin Teaching Hospital. Following ethical approval, thirty-five patients who had at least three posterior teeth caries and met the inclusion criteria were recruited into the study. The 35 patients then received three restorations each of Organically modified ceramics (ORMOCER), Nanohybrid, and micro-hybrid

Results: Thirty-five participants were recruited for this study. Of the 35 participants, 29 (82.9%) were females while 6 (17.1%) were males, giving a female-to-male ratio of 4:1. Each participant had 3 cavities which were restored with each of the test materials, giving a total of 105 restorations. There was a statistically significant finding with those who brushed using the horizontal technique as well as with those who brushed for a longer duration.

Conclusion: The present study showed that oral hygiene habits especially tooth brushing have effects on the clinical performance of Resin-based Composites, though the effects vary depending on the aspect of toothbrushing.

Keywords: Effects, Oral hygiene, Clinical Performance, Posterior restorations,

INTRODUCTION

The search for a material that will meet the present-day demands for good aesthetics and functionality has continued to generate interest in dental material sciences. Resinous materials, especially composite resins have no doubt been employed in meeting some of these demands.[1]

The availability of adhesive systems for tooth coloured restorative materials like composite resin meant increased tooth conservation during tooth preparation.[2] Composite resin was exclusively used in the anterior region (aesthetic zone) initially, but its use has been expanded to include posterior teeth restoration, with improved science of the composite resin.[3]

Patients presenting to the conservative dental clinic expect their tooth-coloured restorations to mimic natural teeth and maintain their appearance for many years. These patients fail to realize that toothbrushing and other oral habits can have negative effects on the aesthetic and biological performance of their restorations. Some of these effects can be assessed using a gloss meter and measuring surface roughness. It is thought that resin-based composites (RBCs) containing smaller filler particles will show less reduction in surface gloss and less surface roughness after brushing than those containing larger irregular filler particles.[4,5] The rough surfaces of dental restorations will likely collect more dental plaque and bacteria compared to smooth surfaces.[6-9] There are increased accumulated plaque levels when the surface roughness is more than 200nm, which can become a source of concern.[10]

The ISO 11609:2010 standard for testing dentifrices uses 10,000 back-and-forth brushing cycles over the specimens using a load of 150 g.[8] It is considered that between 10,000 to 14,600 back-and-forth brushing cycles in these machines correspond to approximately one year of in vivo toothbrushing in a healthy individual.[11-14]

There is a paucity of studies in our environment that assessed the effects of continued oral hygiene practices like toothbrushing by patients who have had tooth-coloured restorations.

This study was therefore aimed at assessing the effects of tooth brushing and other oral habits by patients who had RBCs restorations on the aesthetic and biological performances of RBCs in posterior teeth restorations.

METHOD

This 12-month prospective study was carried out in the conservative clinic of the University of Benin Teaching

Hospital. Following ethical approval, thirty-five patients who had at least three posterior teeth caries and who met the inclusion criteria were recruited into the study. The 35 patients then received three restorations each of Organically modified ceramics (ORMOCER), Nanohybrid, and microhybrid. The patients were advised to carry out their normal oral hygiene practice including toothbrushing. The patients then recurred for a period of 12 months for assessment of the clinical performance of the aesthetic, functional, and biological properties of the restorations using the FDI criteria.[15]

All restorations were clinically evaluated at baseline, after one (1) week, one (1) month, three (3) months, six (6) months, and 12 months by 2 examiners who were calibrated using-Calibb web-based training.[16] The world dental federation (FDI) criteria (Appendix iii) were used for the clinical evaluation. The FDI criteria which were approved in 2007 have been in use since then. It is categorized into three groups: aesthetic parameters which have four criteria, functional parameters with six criteria and biological criteria having six parameters. Each criterion was expressed with five scores, three for acceptable and two for non-acceptable. Under the non-acceptable, one was for reparable and one for replacement. The two blinded examiners involved in the evaluation were not part of the restorative procedure.

In the FDI grading assessment, score 1 means that the quality of the restorations is excellent/fulfills all quality criteria, and the tooth or surrounding tissues are adequately protected.[15] Score 2 is selected when the quality of the restoration is still highly acceptable though one or more criteria deviate from the ideal. Score 3 means that the quality of the restoration is sufficiently acceptable but with minor shortcomings. The restoration is scored 4 when it is not acceptable but reparable while the score 5 is unacceptable requiring replacement.

Data analysis: The questionnaires were screened for completeness by the researcher, coded, and entered into the IBM SPSS Version 21.0 software and analyzed. Univariate analysis was carried out on categorical data such as sex, religion, educational status, and marital status and presented as frequencies and percentages. Numerical data such as age that were normal in distribution were expressed as means ± standard deviation and continuous data that were skewed in distribution were expressed as median (range). A test of association between two nominal variables was done using the Chi-square. However, Fisher 's exact test was done, when the assumptions for the chi-square test were not met. The level of all statistical associations was set at $p< 0.05$. Cohen's kappa inter-examiner reliability score was 0.07 with a P-value of 0.002. This was obtained after the two examiners were duly calibrated and pre-tested. The scores recorded by the two examiners during the pre-test were recorded and entered into SPSS and calculated. The strength of agreement between the two examiners is interpreted as follows; < 0.00=poor, 0.00-0.20=slight, 0.20-0.40=fair, 0.41-0.60=moderate, 0.61-0.80=substantial, 0.81-1.00=almost perfect agreement.

RESULTS

Thirty-five participants were recruited for this study. Of the 35 participants, 29 (82.9%) were females while 6 (17.1%) were males, giving a female-to-male ratio of 4:1. Each participant had 3 cavities which were restored with each of the test materials, giving a total of 105 restorations. All 35 participants in this study were available throughout the duration of the study, giving a 100.0% recall rate.

Table 1: Distribution of Restorations according to the socio-demographic characteristics of the study participants

Characteristics	Frequency (n = 105)	Percentages
Age group (years		
<20	9	8.6
20-30	60	57.1
31-40	21	20.0
41-50	12	11.4
>50	3	2.9
Sex		
Male	18	17.1
Female	87	82.9
Highest level of education		
Secondary	9	8.6
Tertiary	96	91.4
Change in Medical History **Np=35**		
Yes	0	0.0
No	35	100.0

NP=number of patients

Table 1 shows that, of the 105 restorations placed, female participants received the majority, 87 (82.9%) while 18 (17.1%) were placed in the cavities of male participants. More than two-thirds (57.1%) of the restorations were placed in cavities of participants within the age group of 20-30 years while participants in the age group >50 years received the least number (2.9%) of restorations. A greater proportion, 96(91.4%) of the restorations were placed in cavities of participants whose highest level of education was tertiary. There was no change in the medical history of the study participants.

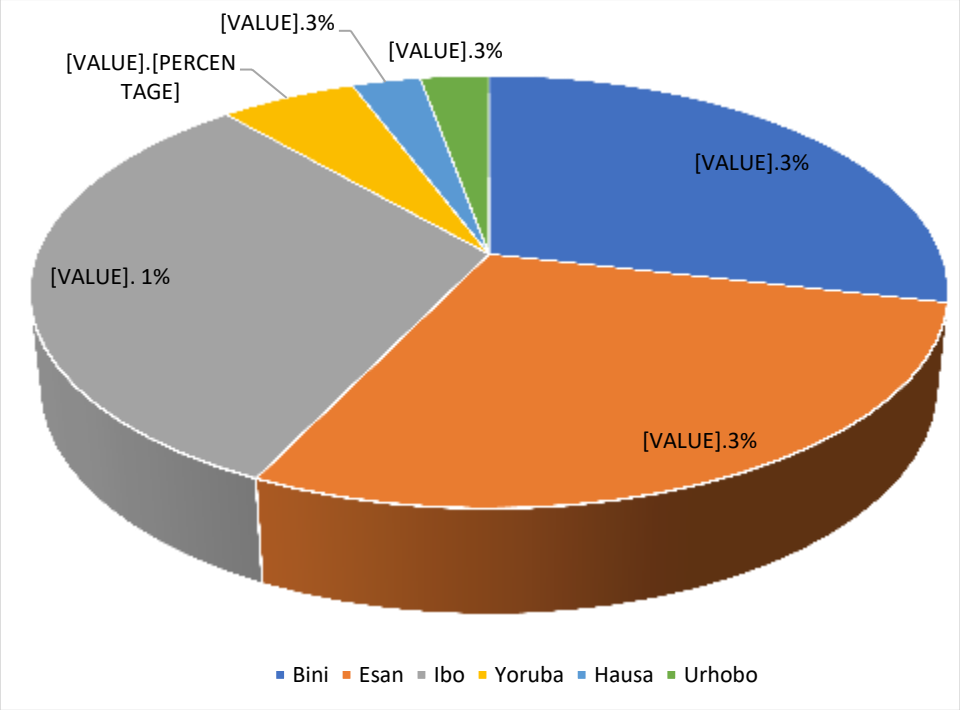

Figure 1: Tribe of the study participants

Fig 1 represents the tribes of the study participants. Bini recorded the highest percentage of participants, 33.1%, with Hausa and Yoruba having the least number, 3.3% each

TABLE 2: EFFECT OF ORAL HYGIENE HABIT ON THE AESTHETIC PERFORMANCE OF STUDY MATERIALS

ORAL HYGIENE HABIT	CATEGORY			P-VALUE
	SCORE 1	SCORE 2	TOTAL	
	N (%)	n (%)	n (%)	
DOMINANT HAND				
RIGHT	87 (90.6)	9 (9.4)	96 (100.0)	0.868
LEFT	8 (88.9)	1 (11.1)	9 (100.0)	
CLEANING AID				
Toothpaste	92 (90.2)	10 (9.8)	102 (100.0)	0.435
Chewing stick +TP	3 (100.0)	0 (0.0)	3 (100.0)	
FREQ OF BRUSH				
ONCE	67 (93.1)	5 (6.9)	72 (100.0)	0.309
TWICE	26(86.7)	4 (13.3)	30 (100.0)	
>TWICE	2(66.7)	1 (33.3)	3 (100.0)	
TECH OF BRUSH				
HORIZONTAL	19 (90.5)	2 (9.5)	21 (100.0)	0.131
VERTICAL	7 (77.8)	2 (22.2)	9 (100.0)	
BOTH	48 (88.9)	6 (11.1)	54 (100.0)	
NO PART.TECH	21 (100.0)	0 (0.05)	21 (100.0)	
BRUSH DURATION				
2-5MINS	87 (96.7)	3 (3.3)	90 (100.0)	
>5MINS	8 (53.3)	7 (46.7)	15 (100.0)	**0.000***
TOTAL	95 (90.5)	10 (9.5)	105 (100.0)	

SCORE 1=EXCELLENT SCORE 2=GOOD TP=TOOTHPASTE *=statistically significant

Table 2 depicts the effects of oral hygiene habits on the aesthetic performance of the study materials. The oral hygiene habits (Dominant use of left or right hand, cleaning aid, frequency of brushing, the technique of brushing) of the study participants did not have any statistically significant effects on the overall aesthetic performance of the test materials with restorations ($p>0.05$). However, the duration of tooth brushing is statistically significantly associated with deterioration in the aesthetics of the material ($p<0.05$). A majority, (90.6%) of the restorations placed in the right-handed participants scored 1 compared to 9.4% of the restorations that scored 2, while all restorations placed in those who brushed with chewing sticks and toothpaste recorded a 100% score of 1.

Similarly, of the participants who used toothpaste, 90.2% of the restorations scored 1 while 9.8% scored 2. A great majority (93.1%) of the restorations placed in those who brushed once daily had a score of 1 compared to 6.9% which had a score of 2.

Among the participants who brushed twice daily, 86.7% of the restorations scored 1 while 13.3% scored 2. The majority (66.7%) of the restorations in those who claimed to brush more than twice a day had a score of 1.

With respect to the technique of toothbrushing, 90.5% of the restorations on those who brushed using the horizontal technique scored 1 compared to 9.5% of restorations that scored 2. With respect to those who brushed using the vertical technique, 77.8% of their restorations had a score of 1 while 22.2% scored 2. An evaluation of those using both aforementioned (horizontal and vertical) techniques showed that 88.9% of the restorations in this category scored 1 with 11.1% recording a score of 2.

With respect to the duration of tooth brushing, a higher proportion, (46.7%) of those that reported brushing for longer than 5 minutes had a score of 2 compared to only 3.3% of those that claimed to brush for between 2 and 5 minutes. This was statistically significant ($p=0.000$).

TABLE 3: EFFECT OF ORAL HYGIENE HABIT ON THE FUNCTIONAL PERFORMANCE OF STUDY MATERIALS

ORAL HYGIENE HABIT	CATEGORY			P-VALUE
	SCORE 1	SCORE 2	TOTAL	
	n (%)	n (%)	n (%)	
DOMINANT HAND				
RIGHT	77 (80.2)	19(19.8)	96 (100.0)	0.501
LEFT	8 (88.9)	1 (11.1)	9 (100.0)	
CLEANING AID				
Toothpaste	82 (80.4)	20 (19.6)	102 (100.0)	0.256
Chewing stick +TP	3 (100.0)	0 (0.0)	3 (100.0)	
FREQ OF BRUSH				
ONCE	60 (83.3)	12 (16.7)	72 (100.0)	0.276
TWICE	22 (73.3)	8 (26.7)	30 (100.0)	
>TWICE	3 (100.0)	0 (0.0)	3 (100.0)	
TECH OF BRUSH				
HORIZONTAL	14 (66.7)	7 (33.3)	21 (100.0)	**0.010***
VERTICAL	7 (77.8)	2 (22.2)	9 (100.0)	
BOTH	43 (79.6)	11 (20.4)	54 (100.0)	
NO PART.TECH	21 (100.0)	0 (0.0)	21 (100.0)	
BRUSH DURATION				
2-5MINS	73 (81.1)	17 (18.95)	90 (100.0)	0.920
>5MINS	12 (80.0)	3 (20.05)	15 (100.0)	
TOTAL	85 (81.0)	20 (19.0)	105 (100.0)	

SCORE 1=EXCELLENT SCORE 2=GOOD, TP=TOOTHPASTE *=statistically significant

Table 3 showed the functional performance of the test materials and oral hygiene practices. The technique (horizontal method) of tooth brushing resulted in a statistically significant deterioration in function ($p=0.010$). However, the other oral hygiene habits (Dominant hand, type of cleaning aids, frequency, and duration of brushing) did not have a statistically significant effect on the functional performance of the study materials ($p>0.05$).

TABLE 4: EFFECT OF ORAL HYGIENE HABIT ON THE BIOLOGICAL PERFORMANCE OF STUDY MATERIALS

ORAL HYGIENE HABIT	CATEGORY			P-VALUE
	SCORE 1 **n** (%)	SCORE 2 **n** (%)	TOTAL n (%)	
DOMINANT HAND				
RIGHT	69 (89.6)	27 (96.4)	96 (100.0)	0.232
LEFT	8 (88.9)	1 (11.1)	9 (100.0%)	
CLEANING AID				
Toothpaste	74 (72.5)	28 (27.5)	102 (100.0)	0.169
Chewing stick+ TP	3 (100.0)	0 (0.0)	3 (100.0)	
FREQ OF BRUSH				
ONCE	57 (79.2)	15 (20.8)	72 (100.0)	0.143
TWICE	18 (60.0)	12 (40.0)	30 (100.0)	
>TWICE	2 (66.7)	1 (33.3)	3 (100.0)	
TECH OF BRUSH				
HORIZONTAL	15 (71.4)	6 (28.6)	21 (100.0)	0.160
VERTICAL	7 (77.8)	2 (22.2)	9 (100.0)	
BOTH	36 (66.7)	18 (33.3)	54 (100.0)	
NO.PART.TECH	19 (90.5)	2 (9.5)	21(100.0)	
BRUSH DURATION				
2-5MINS	68 (75.6)	22 (24.4)	90 (100.0)	0.223
>5MINS	9 (60.0)	6 (40.0)	15 (100.0)	
TOTAL	77 (73.3)	28 (26.7)	105 (100.0)	

From table 4, the effects of oral hygiene habits on the biological performance of the study materials were not statistically significant($p>0.05$). A greater proportion (89.6%) of the restorations placed on teeth in right-handed participants and 72.5% of restorations placed in those who used toothpaste scored 1. All restorations (100.0%) on those who used the chewing stick and 79.2% of restorations on those who brushed once a day also scored 1. More restorations (75.6%) scored 1 among those who spent 2-5 minutes brushing. Overall, 28 restorations scored 2 with biological parameters.

DISCUSSION

The effects of oral hygiene practice on the aesthetic, functional, and biological parameters of the study materials were evaluated. The findings revealed that the effect of oral hygiene habits (dominant hand, cleaning aid, frequency of brushing, techniques of brushing, and duration of cleaning) on the aesthetic performance of the three test materials was not statistically significant. Spending a long time on cleaning seems to affect the clinical aesthetic performance of the study materials as a statistically significant difference was observed with the duration of cleaning ($p=0.000$). The majority of restorations placed in participants who were the right-handed recorded excellent aesthetic outcome. Similar results were obtained for cleaning aid, frequency, and technique of tooth brushing. In a study, Roselino Lde et al studied the effect of brushing time and dentifrice abrasiveness on colour change and surface roughness of resin composites and reported surface roughness with increased time of brushing.[17] O'Neil et al reported that the gloss of admira fusion (ORMOCER) was the most affected by toothbrushing.[18] A few studies[19-21] have reported a statistically significant association between toothbrushing generally and the clinical performance of composite restorations. They reported a statistically significant difference between restorative materials and toothbrushing with regard to colour change. On the functional parameters of the test materials, there was a statistically significant difference in the functional properties of the study materials with the technique of toothbrushing, with the highest percentage of score 2 in restorations of those using horizontal technique indicating that the technique of toothbrushing may have an effect on the functional failure of the test materials.

There were changes in the scores for restorations by other oral hygiene habits, which were not statistically significant. A majority (80.2%) of the restorations on righted-handed participants scored 1 while 19.8% of restorations scored 2. Similar results were obtained for cleaning aid where more than two-thirds (80.4%) of the restorations placed on participants who used toothpaste scored 1. The effects of frequency and duration of toothbrushing on the functional properties of the study materials did not produce any statistically significant difference in the functional performance of the test materials. In a study[22] conducted by Bizhang and others, they reported an association between the technique of brushing and its effects. In a study by Pinto and co,[23] to compare the effect of toothbrush abrasiveness on different tooth-coloured restorative materials, the results revealed that the surface characteristics of restorative dental materials were modified by toothbrushing. This is a study consistent with the results of our present study.

Dentifrices' have been known to contribute significantly to the surface roughness RBCs as reported by some studies. [24,25,26] However, the present study did not consider the type of dentifrices used by each patient. It is a possibility that the type of toothpaste may have also contributed to the clinical changes observed in this study.

CONCLUSION

The present study showed that oral hygiene habits especially tooth brushing have effects on the clinical performance of Resin-based Composites, though the effects vary depending on the aspect of toothbrushing. The duration and technique of toothbrushing had the most profound effects on these restorations, especially on the functional and biological performances of the restorations. Therefore, patients with RBCs should be advised to be more careful with toothbrushing.

ACKNOWLEDGEMENT

We acknowledge the contributions of members of staff of the restorative clinic of the Univeristy of Benin Teaching Hospital. Sincere appreciation to Dr Ehizele A and Dr Chuckuma Nneka for helping to proof read this manuscript.

CONFLICT OF INTEREST

I wish to say that there was no conflict of interest during the course of carrying out this research work and that I received no financial assistance towards the study.

REFERENCES

1. Fagundes TC, Barata TJ, Bresciani E, Cefaly DF, Jorge MF, Navarro MF. Clinical evaluation of two packable posterior composites: 2-year follow-up. Clin Oral Investig. 2006; 10:197-203. https://doi.org/10.1007/s00784-006-0059-y

2. Gbadebo SO, Anifowose OO, Ogunrinde TJ. Trend of posterior teeth restoration at Ibadan, Nigeria, J West Afr Coll Surg. 2013; 3: 70-83.

3. Ben-Gal G, Weiss EI. Trends in material choice for posterior restorations in an Israeli dental school: Composite resin versus Amalgam. J Dent Educ. 2011; 75:1590-1595. https://doi.org/10.1002/j.0022-0337.2011.75.12.tb05219.x

4. da Costa J, Adams-Belusko A, Riley K, Ferracane JL. The effect of various dentifrices on surface roughness and gloss of resin composites. J Dent. 2010; 38 Suppl 2:e123-128. https://doi.org/10.1016/j.jdent.2010.02.005

5. O'Neill C, Kreplak L, Rueggeberg FA, Labrie D, Shimokawa CAK, Price RB. Effect of tooth brushing on gloss retention and surface roughness of five bulk-fill resin composites. J Esthet Restor Dent. 2018; 30(1):59-69. https://doi.org/10.1111/jerd.12350

6. Carlen A, Nikdel K, Wennerberg A, Holmberg K, Olsson J. Surface characteristics and in vitro biofilm formation on glass ionomer and composite resin. Biomaterials. 2001; 22(5):481-487. https://doi.org/10.1016/S0142-9612(00)00204-0

7. Bollen CM, Lambrechts P, Quirynen M. Comparison of surface roughness of oral hard materials to the threshold surface roughness for bacterial plaque retention: a review of the literature. Dent Mater. 1997; 13(4):258-269. https://doi.org/10.1016/S0109-5641(97)80038-3

8. Mei L, Busscher HJ, van der Mei HC, Ren Y. Influence of surface roughness on streptococcal adhesion forces to composite resins. Dent Mater. 2011; 27(8):770-778. https://doi.org/10.1016/j.dental.2011.03.017

9. Wongpraparatana I, Matangkasombut O, Thanyasrisung P, Panich M. Effect of Vital Tooth Bleaching on Surface Roughness and Streptococcal Biofilm Formation on Direct Tooth-Colored Restorative Materials. Oper Dent. 2018; 43(1):51-59. https://doi.org/10.2341/16-366-L

10. ISO 11609:2010(E) Dentistry-Dentifrices-Requirements, test methods and marking. Geneva, Switzerland: International Standards Organization; 2010:20.

11. dos Santos PH, Consani S, Correr Sobrinho L, Coelho Sinhoreti MA. Effect of surface penetrating sealant on roughness of posterior composite resins. Am J Dent. 2003; 16(3):197-201.

12. Barbieri GM, Mota EG, Rodrigues-Junior SA, Burnett LH, Jr. Effect of whitening dentifrices on the surface roughness of commercial composites. J Esthet Restor Dent. 2011; 23(5):338-345. https://doi.org/10.1111/j.1708-8240.2011.00426.x

13. Monteiro B, Spohr AM. Surface Roughness of Composite Resins after Simulated Toothbrushing with Different Dentifrices. J Int Oral Health. 2015;7(7):1-5.

14. Roselino Lde M, Chinelatti MA, Alandia-Roman CC, Pires-de-Souza Fde C. Effect of Brushing Time and Dentifrice Abrasiveness on Color Change and Surface Roughness of Resin Composites. Braz Dent J. 2015; 26(5):507-513. https://doi.org/10.1590/0103-6440201300399

15. Hickel R, Peschke A, Tyas M, Mjör I, Bayne S, Peters M et al. FDI World Dental Federation - clinical criteria for the evaluation of direct and indirect restorations: update and clinical examples. J Adhes Dent. 2010; 12:259-331 https://doi.org/10.1007/s00784-010-0432-8

16. Hickel R, Peschke A, Tyas M, Mjör I, Bayne S, Peters M et al. FDI World Dental Federation: clinical criteria for the evaluation of direct and indirect restorations-update and clinical examples. Clin Oral Investig. 2010; 14:349-366. https://doi.org/10.1007/s00784-010-0432-8

17. Roselino Lde L, Chinelatti MA, Alandia-Roman CC, Pires-de-Souza Fde C. Effect of Brushing Time and Dentifrice Abrasiveness on Color Change and Surface Roughness of Resin Composites. Braz Dent J. 2015; 26:507-513 https://doi.org/10.1590/0103-6440201300399

18. O'Neill C, Kreplak L, Rueggeberg FA, Labrie D, Shimokawa CAK, Price RB. Effect of tooth brushing on gloss retention and surface roughness of five bulk-fill resin composites. J Esthet Restor Dent. 2018; 30: 59-69 https://doi.org/10.1111/jerd.12350

19. Alzayer F, Alawami R. Effect of tooth brushing on color changes of esthetic restorative materials. Int J Res Med Sci. 2018; 6: 3860-3864. https://doi.org/10.18203/2320-6012.ijrms20184608

20. Lessly A. Garza G T, Seok-Hwan M Ch, David MS, Berzins W. Effect of toothbrushing on shade and surface roughness of extrinsically stained pressable ceramics. Dent.2016; 115:489-494. https://doi.org/10.1016/j.prosdent.2015.09.013

21. O'Neill C, Kreplak L, Rueggeberg FA, Labrie D, Shimokawa CAK, Price RB, et al. Effect of tooth brushing on gloss retention and surface roughness of five bulk-fill resin composites. J Esthet Rest Dent. 2018; 30:59-69. https://doi.org/10.1111/jerd.12350

22. Bizhang M, Schmidt I, Chun YHP, Arnold WH, Zimmer S. Toothbrush abrasivity in a long-term simulation on human dentin depends on brushing mode and bristle arrangement. PLoSONE 2017; 12: e0172060. https://doi.org/10.1371/journal.pone.0172060

23. Paulo Pinto, A. Carvalho, Filipe Silva, J. R. Gomes. Comparative toothbrush abrasion resistance and surface analysis of different dental restorative materials. Tribology International, 2022; 175(Suppl 2):107799 https://doi.org/10.1016/j.triboint.2022.107799

24. Cury JA, Rosing CK, Tenuta LM. Are dentifrices all the same? Int J Braz Dent. 2010; 6:254-6. [Google Scholar]

25. Kodaka T, Kuroiwa M, Kuroiwa M, Okumura J, Mori R, Hirasawa S, et al. Effects of brushing with a dentifrice for sensitive teeth on tubule occlusion and abrasion of dentin. J Electron Microsc (Tokyo) 2001; 50(1):57-64. https://doi.org/10.1093/jmicro/50.1.57

26. Binhasan M, Solimanie AH, Almuammar KS, Alnajres AR, Alhamdan MM, Al Ahdal K, Alfaawaz YF, Ali K, Vohra F, Abduljabbar T. The Effect of Dentifrice on Micro-Hardness, Surface Gloss, and Micro-Roughness of Nano Filled Conventional and Bulk-Fill Polymer Composite-A Micro Indentation and Profilometric Study. Materials (Basel). 2022 Jun 20; 15(12):4347. PMID: 35744406; PMCID: PMC9229010. https://doi.org/10.3390/ma15124347