Colour Stability of Composite Resins - A Review

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Abstract

Composite resins are the most preferred dental materials for anterior and posterior teeth. They have an important role in aesthetic and restorative dentistry. Paramount importance of composite resins are they have an Optical appearance, glossy surface and colour stability. There are three types of composite resins Conventional(Packable), Flowable(Bulkfill),Microfill. Hybrid,Fluoride releasing composites. Color change of composite restoration in different color media during the time is a common problem in esthetic dentistry, causing the need to replace restoration and spending a great deal of cost and time to patients. The aim of this study is to present a short review of recent literature available on the association of colour stability of composite resins. The article was done after reviewing several articles on the colour stability of composite resins. The effect on colour stability of composite resins depends on type of solution exposure time and composition of material. In clinical practice, patients should be aware of the staining effects, as staining in anterior teeth may lead to unaesthetic appearance.

Keywords: *Colour stability , Esthetic Restorative materials, Discolouration , Surface roughness.*

Introduction

Colour stability of composite resin is a crucial property influencing clinical longevity , which continues as a challenge inherent to material [1] .Colour changes can occur because of staining in a superficial layer of resin composite , water absorption ,surface roughness ,smoking and diet [2]. Intrinsic discoloration can occur as a result of physio mechanical reaction within the fabric material example the filler and resins matrix properties [3]. It is documented that the original colour of composite resins are often changed within a particular period of time[4] . Long term colour changes in composite restorations can occur due to surface and marginal staining, microleakage, wear dependent surface changes and internal material deterioration ,which may compromise the visual acceptability of those restorations and end in additional expenses for replacement [5,6]. Secondary caries were the most main reason for failure of resin composites , followed by discoloration. This process concerns patients and dentists and consumes time and money. Not all alterations might be related with surface degradation [7]

Discoloration of composite resins are often caused by internal or external factors . Internally induced discoloration are permanent and are relatable polymer quality , filler type and amount ,as well because the synergist is added to the photoinitiator system [8]. The resin's affinity for extrinsic stains is modulated by its conversion rate and physico chemical characteristics with water sorption rate being of particular importance [9] . Within the mouth due to superficial degradation or a small penetration and adsorption of staining agents at the superficial layer of composite resins discoloration of surface subsurface of resin restoration may result. Moreover externally induced discoloration is often

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associated with surface roughness, surface integrity and therefore the polishing technique [10,11] .

Generally it's recommended that resins should be placed in 2mm increments to urge sufficient light transmittance and complete curing of composite resins [12] .The application of composite resins in an incremental technique and light weight curing each increment individually may be a time-consuming procedure[13] .

In addition to colour alteration a number of these products also can cause superficial degradation on the composite surface by reducing its microhardness which could possibly favour more superficial staining[14]. Corroborating this theory Okte Et Al showed decreased microhardness valves of microhybrid and nano resin composite after immersion in both coffee and wine solutions [15] .

Materials and Method

Study setting was made by sampling reviews. Number of articles taken 25. Search engines used are "Google Scholar and PUBMED". Search terms are used in relation with colour stability of composite resins. There are five steps selected on the article.They are Identification of clear subjects , Identification of relevant articles, Selection, Data Extraction and Charting , Analysis and report. The articles selected based on recent similar and relevant publications.Article selection include articles with recent advancement in colour stability of composite resins. Scoring was done for all 25 articles.

Composite resins

Composite resins represent one of successes of biomaterial research ,since they replaced biological tissue in both appearance and performance. A minimum of half posterior direct restoration placements now believe composite materials [16]. Unfortunately demands on these restoration with regard to mechanical properties, placement and need for in-situ curing leave significant room for advancements, particularly the mechanical properties of polymerization shrinkage and polymerization induced stress ,thermal expansion mismatch, Fracture abrasions and wear resistance marginal leakage and toxicity [17] . Ultimately, these shortcomings reduce a restoration's lifetime and represent the drive factor for improvement in dental composites clinical evaluations and laboratory based studies focused on composite durability also still highlight this need for brand fresh materials[18]. Review discussed development of polymeric composite resins focussing on methods for reducing polymerization shrinkage and achieving improvements in biocompatibility and wear resistance [19,20] .

Photo initiation

Though non-photoinitiated polymerization are still performed and studied, photoinitiated polymerization have enormous value in controlling polymerization temporally,allowing adequate time for placement and manipulation of restorative before curing [21,22] . Clinically desirable visible light has reduced energy per photon relative to UV light ,which limits the selection of suitable inhibitors and sometimes necessitates multicomponent initiators. Additionally there remains concerns over the toxicity of amine co initiators that are used with camphorquinone. Ultimately,these needs drive the investigation of a replacement photoinitiator system [23].

Colour testing

A colorimetric evaluation to the CIELab system was performed by a blind trained operator at five experiments periods immediately after light polymerization and at 7 ,14 ,21, 28 days of staining process.colour of the specimens was measured with spectrophotometer against a background in order to stimulate absence of light in mouth against a white background [24] . FilTek supreme has almost the same matrix formulation as FilTek Z250 & P60 with exception of containing small amounts of TEGDMA which might be responsible for the high water absorption and discolouration rates. Chlorhexidine application, either in an aqueous solution or associated with the acid conditioner, preserves durability of the resin-dentin interface. Further *in vivo* studies are needed to clarify whether the use of a 2% CHX-containing acid preserves resin-dentin interface after long-term function [25]. According Umand Ruyte Et Al Cola had lowest pH and it might damage surface integrity of composite resin materials.It did not produce any as discoloration as coffee and tea possibly due to its lack of yellow colourant.Both coffee and tea contained yellow colourant which had different polarities,It is

noteworthy that materials which contained TEGDMA showed higher discoloration values meaning TEGDMA was responsible for discoloration due to hydrophilic character [26] .In clinical practices patients should be aware of staining effects of drinks tested in this study, while practitioners should take into consideration the staining susceptibility of composite resins [27] .

Effects of foods And beverages on composite resins

According to Bagheri Et Al [28] , composite resins are able to absorb water,then it is capable of absorbing other fluids resulting in its discoloration and in the reduction of mechanical properties due to polymer matrix degradation [29] . Fluid absorption occurs mainly as direct absorption in resin matrix.Glass filler particles will not absorb water onto the surface. The ability of composite to absorb fluids is strongly related to the nature of material, where hydrophobic material with absence of hydroxyl group in their composition showed low water sorption but were stained by hydrophobic solutions,whereas hydrophilic materials with high degree of water sorption were stained by hydrophilic substances in aqueous solutions the other substances that also had an impact on composite colour were ketchup another condiment is very popular among populations all over the world and its red colour is attributed to a substance called lycopene is also insoluble in water [30] .

The colour of grapes comes from anthocyanins, which are water soluble vacuolar pigments that may appear red, purple or blue according to pH [31] . Differently from the pigments found in mustard and in ketchup anthocyanins are hydrophilic and so is the caramel colouring,pigment present in soy sauce. In order to prevent the mechanical retention of these pigments on the composite surface,all specimen were washed and brushed before each evaluation [32] Immersion of specimens in deionized water did not alter colour of composite to a considerable extent,Although a perceptible colour alteration could be noticed after 7 days in this group. Fontes Et Al believe that low pH of fruit juice affects the resin surface increasing pigment absorption. According to Mundim Et al [33] , patients should last and whether their eating habits may influence quality and longevity of restoration . Knowledge of effects of staining potential on the surface of composite resin could guide clinicians as regards instruction, give their patients after operator procedure, to assure better colour [34] stability and long term maintenance of restoration.

Tooth brushing simulation on composite resins

Degradation of composite material can occur due to mechanical and chemical factors from the oral environment which can cause changes in surface roughness, loss of surface gloss and increased discolouration of material affecting esthetic quality of restoration [35] . In non stress bearing areas main causal factors of texture changes are the relationship between biodegradation and oral hygiene procedures [36] . Abrasions of composite resins were affected more by the toothpaste's abrasiveness than by toothbrush filament diameter. It is important to notice that the pattern of toothbrushing wear on restorative materials was the result of interaction of several factors and studies have reported the effects on GIC, pit and fissure sealants. [37]According to Gurgan et al mouthrinses can affect the hardness of restorative materials, alcohol content is not only a factor that has softening effect on materials for example showed higher roughness resulting saliva immersion compared with a mouthrinse [38] .

Conclusion

Composites have undeniably obtained a prominent place among the filling materials utilized in direct methods. Their significant stylish prospects offer ascent to an assortment of restorative signs, which keep on developing because of the extraordinary flexibility of the introductions offered; likewise, these materials preserve the tooth structure better since they are held by cement techniques as opposed to relying upon cavity plan. With this help of a review article we can conclude that Color stability is the ability of materials to retain their original color. Daily intake of food with staining ability such as tea, coffee, and cola can compromise esthetics of restorative materials. Understanding the property of color stability and the comparative analysis of various restorative materials will help a clinician to choose the materials as per the diet habits of the patients and ensure predictability of success. It will also enable the clinician to educate and counsel the patient about the effects of specific chromogenic ingredients in the diet such as tea, coffee, and wine on the color stability of the restorative material used.

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Ethical Clearance: As it is a review article so it is not required.

References

1. Ruyter IE, Nilner K, Moller B. Color stability of dental composite resin materials for crown and bridge veneers. Dent Mater [Internet]. 1987 Oct;3(5):246–51. Available from: http://dx.doi.org/10.1016/S0109-5641(87)80081-7
2. Nasim I, Neelakantan P, Sujeer R, Subbarao CV. Color stability of microfilled, microhybrid and nanocomposite resins—An in vitro study [Internet]. Vol. 38, Journal of Dentistry. 2010. p. e137–42. Available from: http://dx.doi.org/10.1016/j.jdent.2010.05.020
3. Gönülol N, Yilmaz F. The effects of finishing and polishing techniques on surface roughness and color stability of nanocomposites. J Dent [Internet]. 2012 Dec;40 Suppl 2:e64–70. Available from: http://dx.doi.org/10.1016/j.jdent.2012.07.005
4. Ramamoorthi S, Nivedhitha MS, Divyanand MJ. Comparative evaluation of postoperative pain after using endodontic needle and EndoActivator during root canal irrigation: A randomised controlled trial. Aust Endod J [Internet]. 2015 Aug;41(2):78–87. Available from: http://dx.doi.org/10.1111/aej.12076
5. Ramanathan S, Solete P. Cone-beam Computed Tomography Evaluation of Root Canal Preparation using Various Rotary Instruments: An in vitro Study [Internet]. Vol. 16, The Journal of Contemporary Dental Practice. 2015. p. 869–72. Available from: http://dx.doi.org/10.5005/jp-journals-10024-1773
6. Nathoo SA. The chemistry and mechanisms of extrinsic and intrinsic discoloration. J Am Dent Assoc [Internet]. 1997 Apr;128 Suppl:6S – 10S. Available from: http://dx.doi.org/10.14219/jada.archive.1997.0428
7. Um CM, Ruyter IE. Staining of resin-based veneering materials with coffee and tea. Quintessence Int [Internet]. 1991 May;22(5):377–86. Available from: https://www.ncbi.nlm.nih.gov/pubmed/1924691
8. Al-Abdullah AS, Al-Bounni RS, Al-Omari M. Color Stability of Tetric® N-Ceram Bulk Fill Restorative Composite Resin after Immersion in Different Drinks [Internet]. Journal of Academy of Advanced Dental Research. 2017. p. 222941121772908. Available from: http://dx.doi.org/10.1177/2229411217729080
9. Villalta P, Lu H, Okte Z, Garcia-Godoy F, Powers JM. Effects of staining and bleaching on color change of dental composite resins. J Prosthet Dent [Internet]. 2006 Feb;95(2):137–42. Available from: http://dx.doi.org/10.1016/j.prosdent.2005.11.019
10. Siddique R, Sureshbabu NM, Somasundaram J, Jacob B, Selvam D. Qualitative and quantitative analysis of precipitate formation following interaction of chlorhexidine with sodium hypochlorite, neem, and tulsi. J Conserv Dent [Internet]. 2019 Jan;22(1):40–7. Available from: http://dx.doi.org/10.4103/JCD.JCD_284_18
11. Khokhar ZA. In-vitro Study of the Color Stability of Modern Restorative Resins: A Thesis Submitted in Partial Fulfillment ... Prosthodontics .. [Internet]. 1989. 224 p. Available from: https://books.google.com/books/about/In_vitro_Study_of_the_Color_Stability_of.html?hl=&id=dSFqAAAAMAAJ
12. R R, Rajakeerthi R, Ms N. Natural Product as the Storage medium for an avulsed tooth – A Systematic Review [Internet]. Vol. 22, Cumhuriyet Dental Journal. 2019. p. 249–56. Available from: http://dx.doi.org/10.7126/cumudj.525182
13. Gross MD, Moser JB. A colorimetric study of coffee and tea staining of four composite resins [Internet]. Vol. 4, Journal of Oral Rehabilitation. 1977. p. 311–22. Available from: http://dx.doi.org/10.1111/j.1365-2842.1977.tb00997.x
14. Rajendran R, Kunjusankaran RN, Sandhya R, Anilkumar A, Santhosh R, Patil SR. Comparative Evaluation of Remineralizing Potential of a Paste Containing Bioactive Glass and a Topical Cream Containing Casein Phosphopeptide-Amorphous Calcium Phosphate: An in Vitro Study [Internet]. Vol. 19, Pesquisa Brasileira em Odontopediatria e

Clínica Integrada. 2019. p. 1–10. Available from: http://dx.doi.org/10.4034/pboci.2019.191.61

15. Jung J-E, Lee W, Son S-A, Kwak S-W, Kwon YH, Park J-K. The Color Stability of Resin Composite After Exposure to pH Solutions and Immerse Into Staining Beverages [Internet]. Vol. 43, Korean Journal of Dental Materials. 2016. p. 111–20. Available from: http://dx.doi.org/10.14815/kjdm.2016.43.2.111
16. Pilo R, Oelgiesser D, Cardash HS. A survey of output intensity and potential for depth of cure among light-curing units in clinical use. J Dent [Internet]. 1999 Mar;27(3):235–41. Available from: http://dx.doi.org/10.1016/s0300-5712(98)00052-9
17. Ertas E, Güler AU, Yücel AÇ, Köprülü H, Güler E. Color Stability of Resin Composites after Immersion in Different Drinks [Internet]. Vol. 25, Dental Materials Journal. 2006. p. 371–6. Available from: http://dx.doi.org/10.4012/dmj.25.371
18. Hussainy SN, Nasim I, Thomas T, Ranjan M. Clinical performance of resin-modified glass ionomer cement, flowable composite, and polyacid-modified resin composite in noncarious cervical lesions: One-year follow-up. J Conserv Dent [Internet]. 2018 Sep;21(5):510–5. Available from: http://dx.doi.org/10.4103/JCD.JCD_51_18
19. Bagheri R, Burrow MF, Tyas M. Influence of food-simulating solutions and surface finish on susceptibility to staining of aesthetic restorative materials. J Dent [Internet]. 2005 May;33(5):389–98. Available from: http://dx.doi.org/10.1016/j.jdent.2004.10.018
20. Kumar D, Delphine Priscilla Antony S. Calcified Canal and Negotiation-A Review [Internet]. Vol. 11, Research Journal of Pharmacy and Technology. 2018. p. 3727. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00683.2
21. Yannikakis SA, Zissis AJ, Polyzois GL, Caroni C. Color stability of provisional resin restorative materials [Internet]. Vol. 80, The Journal of Prosthetic Dentistry. 1998. p. 533–9. Available from: http://dx.doi.org/10.1016/s0022-3913(98)70028-9
22. Ravinthar K, Jayalakshmi. Recent Advancements in Laminates and Veneers in Dentistry [Internet]. Vol. 11, Research Journal of Pharmacy and Technology. 2018. p. 785. Available from: http://dx.doi.org/10.5958/0974-360x.2018.00148.8
23. Ferracane JL, Marker VA. Solvent Degradation and Reduced Fracture Toughness in Aged Composites [Internet]. Vol. 71, Journal of Dental Research. 1992. p. 13–9. Available from: http://dx.doi.org/10.1177/00220345920710010101
24. Manabe A, Kato Y, Finger WJ, Kanehira M, Komatsu M. Discoloration of coating resins exposed to staining solutions in vitro [Internet]. Vol. 28, Dental Materials Journal. 2009. p. 338–43. Available from: http://dx.doi.org/10.4012/dmj.28.338
25. Noor SSSE, S Syed Shihaab, Pradeep. Chlorhexidine: Its properties and effects [Internet]. Vol. 9, Research Journal of Pharmacy and Technology. 2016. p. 1755. Available from: http://dx.doi.org/10.5958/0974-360x.2016.00353.x
26. Kalampalikis E, Koulaouzidou EA, Koliniotou-Koumpia E, Helvatjoglu- Antoniades M. The Influence of Topical Fluoride Application on Colour Stability of Aesthetic Fluoride-Releasing Restorative Materials [Internet]. Vol. 18, Balkan Journal of Dental Medicine. 2014. p. 24–8. Available from: http://dx.doi.org/10.1515/bjdm-2015-0003
27. Teja KV, Ramesh S, Priya V. Regulation of matrix metalloproteinase-3 gene expression in inflammation: A molecular study. J Conserv Dent [Internet]. 2018 Nov;21(6):592–6. Available from: http://dx.doi.org/10.4103/JCD.JCD_154_18
28. Stober T, Gilde H, Lenz P. Color stability of highly filled composite resin materials for facings. Dent Mater [Internet]. 2001 Jan;17(1):87–94. Available from: http://dx.doi.org/10.1016/s0109-5641(00)00065-8
29. Janani K, Palanivelu A, Sandhya R. Diagnostic accuracy of dental pulse oximeter with customized sensor holder, thermal test and electric pulp test for the evaluation of pulp vitality - An in vivo study [Internet]. Vol. 23, Brazilian Dental Science. 2020. Available from: http://dx.doi.org/10.14295/bds.2020.v23i1.1805
30. Sideridou I, Tserki V, Papanastasiou G. Study of water sorption, solubility and modulus of elasticity of light-cured dimethacrylate-based dental resins.

Biomaterials [Internet]. 2003 Feb;24(4):655–65. Available from: http://dx.doi.org/10.1016/s0142-9612(02)00380-0

31. Jose J, P. A, Subbaiyan H. Different Treatment Modalities followed by Dental Practitioners for Ellis Class 2 Fracture – A Questionnaire-based Survey [Internet]. Vol. 14, The Open Dentistry Journal. 2020. p. 59–65. Available from: http://dx.doi.org/10.2174/1874210602014010059
32. Gonçalves SE de P, de Paiva Gonçalves SE, da Silva TM, da Silva NY, Gonçalves LL, Alves LP, et al. Staining Beverages and Cigarette Smoke on Composite Resin and Human Tooth Fluorescence by Direct Spectrometry [Internet]. Vol. 18, The Journal of Contemporary Dental Practice. 2017. p. 352–7. Available from: http://dx.doi.org/10.5005/jp-journals-10024-2045
33. Douglas WH, Craig RG. Resistance to Extrinsic Stains by Hydrophobic Composite Resin Systems [Internet]. Vol. 61, Journal of Dental Research. 1982. p. 41–3. Available from: http://dx.doi.org/10.1177/00220345820610010901
34. Elhamid MA, Abd Elhamid M, Mosallam R. Effect of bleaching versus repolishing on colour and surface topography of stained resin composite [Internet]. Vol. 55, Australian Dental Journal. 2010. p. 390–8. Available from: http://dx.doi.org/10.1111/j.1834-7819.2010.01259.x
35. Manohar MP, Sharma S. A survey of the knowledge, attitude, and awareness about the principal choice of intracanal medicaments among the general dental practitioners and nonendodontic specialists. Indian J Dent Res [Internet]. 2018 Nov;29(6):716–20. Available from: http://dx.doi.org/10.4103/ijdr.IJDR_716_16
36. Satou N, Khan AM, Matsumae I, Satou J, Shintani H. In vitro color change of composite-based resins. Dent Mater [Internet]. 1989 Nov;5(6):384–7. Available from: http://dx.doi.org/10.1016/0109-5641(89)90105-x
37. Nandakumar M, Nasim I. Comparative evaluation of grape seed and cranberry extracts in preventing enamel erosion: An optical emission spectrometric analysis. J Conserv Dent [Internet]. 2018 Sep;21(5):516–20. Available from: http://dx.doi.org/10.4103/JCD.JCD_110_18
38. Website [Internet]. [cited 2020 Jun 5]. Available from: Teja KV, Ramesh S. Shape optimal and clean more. Saudi Endod J [serial online] 2019 [cited 2020 Jun 5];9:235-6. Available from: http://www.saudiendodj.com/text.asp?2019/9/3/235/264648 Sir,