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An investigation into the effect of try-in pastes, uncured and cured resin cements on the overall color of ceramic veneer restorations: An *in vitro* study

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ABSTRACT

Objectives: The aim of this study was to assess how different shades of try-in pastes, uncured and cured resin cements influence the overall color of porcelain veneer restorations.

Methods: Porcelain veneers of shade Vita 1M1 VM7 and 1 mm thick were applied to bovine teeth using three shades of resin cement and their try-in paste produced by three manufacturers. Analysis of variance was carried out on the color difference values (ΔE^*) between the Aquagel and both the try-in paste and cured resins. An assessment of the clinical significance of ΔE^* between the try-in paste and the cured resin and also between the uncured and cured resin was made.

Results: There were statistically significant differences in veneers' colors when using different shades of both Calibra and Nexus resin cements ($p < 0.05$). Also, statistically significant differences were noticed when using different shades of both Rely-X and Nexus try-in pastes ($p < 0.05$). Color differences produced between the try-in pastes and the corresponding shades of cured resin cements ranged from ΔE^* 1.05 to 3.34. The color differences between uncured and cured resins of the same shade ranged from ΔE^* 0.78 to 1.41.

Conclusions: Different colored try-in pastes and resin cements produced color changes which are clinically useful in changing the color of veneer restorations and therefore aid color matching to adjacent dentition. Clinically significant differences were found between try-in pastes and the cured resin of the same shade, however, there were relatively small changes measured between uncured and cured resins. The color match achieved by the try-in paste has to be treated with caution and further assessment of the restoration made with the resin in place before curing is recommended.

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1. Introduction

It is well established that dental appearance is of importance to patients and may have a significant effect on psychological parameters such as self esteem.^{1–3} It is also the case that patients are now better informed of the options for improving the aesthetics of their teeth.^{1,2} One option for aesthetic

restoration of anterior teeth is the use of veneers which are applied to the labial surfaces of anterior teeth. The materials and methods used to achieve veneering include preformed and laboratory-fabricated acrylic veneers, direct and indirect composite resins and all-ceramic veneers.⁴ Moreover, using porcelain veneers and other all-ceramic restorations to correct discolored or malformed anterior teeth has become a popular

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and standard procedure in aesthetic dentistry.⁵ Ninety one percent of practitioners in a survey identified veneers as an ethical choice to treat aesthetic problems.⁶

Guidelines produced by the Royal College of Surgeons of England describe a number of situations where the use of porcelain veneers is indicated.⁷ Typically, ceramic veneers are used to alter the color or shape of anterior teeth such as discolored or hypoplastic teeth, fractured incisors or teeth where the morphology or alignment is causing poor aesthetics. Preparations for ceramic veneers, which are typically very conservative, allow the preparation to remain within enamel.⁸ This reduces the risk of pulpal injury and gives a more predictable adhesion than when bonding to dentine.^{9,10}

A significant component of the aesthetic value is the color match of any restoration to the existing dentition. This should preferably be carried out prior to any tooth preparation and potential drying of adjacent teeth which will alter their color.¹¹ The shade is then chosen to visually match a shade guide such as the Vita Lumin shade guide tab system (Vita, Zahnfabrik, Bad Säckigen, Germany) and the porcelain veneer is then produced to match the prescribed shade. It is preferable to involve the patient in the shade selection process. The veneer that is produced in this preparation is ideally thin and translucent so as to avoid an opaque, “lifeless” appearance.¹²

Resin cements are the adhesive of choice for veneers as they have a favourable fracture load, good longevity and satisfactory clinical performance.¹³ The resin adhesive is used in a thin layer, as increased thickness may also produce a lifeless aesthetic result.⁸ Resins are produced by several manufacturers and are produced in different shades (Calibra is produced in light, medium, dark, opaque and transparent shades. Nexus Universal Luting system is produced with light, dark and neutral shades. Rely-X-Unicem Veneer cement is produced with Translucent, Opaque/Yellow Opaque, White Opaque, A5 Opaque/Dark, A1/Light Yellow and B0.5/White).

The shade of a porcelain veneer is determined by several factors which include the color and the thickness of the porcelain veneer, the thickness and the color of the luting cement and the color of the underlying tooth structure.^{14–17} Generally, a relatively thin translucent porcelain veneer cemented to sound non-discolored tooth could produce a good aesthetic result.¹⁸ However, when a porcelain veneer does not give a pleasing color match to the adjacent teeth, practitioners often use resin cements of different shades in an attempt to mask the underlying tooth structure and modify the final color of the porcelain veneer restoration to attain a satisfactory color match.¹⁹ However, there is no agreement in the literature about the influence of the cement shade on the overall color of porcelain veneer restorations or about whether different shades will produce a varied amount of color change of the final restorations. Some studies have revealed that the resin cement shade may produce significant color differences of the final porcelain restorations.^{19,20} On the other hand, other studies noticed no significant influences of the resin cement on the overall color of IPS Empress all-ceramic materials.^{14,21} Moreover, color shifts caused by different resin cement shades were not significantly different at any of 0.5, 1, 2 and 3 mm thicknesses of IPS Empress

ceramic restorations.²² Similarly, seven different shades of resin cements had no significant effect on the overall color of porcelain veneers.²³ These different results might be due to the varied experimental methodologies conducted and varied perceptibility and acceptability thresholds used to compare the color findings.

Each of the resins is supplied with a try-in paste to give a visual indication of the color of the final restoration before final bonding. The stated purpose of these different shades of resin and try-in pastes is to improve the color matching and aesthetics of the final restoration. However, the agreement between the try-in pastes and resin cements in producing the same color of the final porcelain restoration is critical. Some available brands of the resin cements have try-in pastes which match the color of the set cements well, while some other do not produce a well match between the try-in paste and the cement.^{24,25} Moreover, agreement between try-in paste and the corresponding shade of resin cement were noticed in some shades rather than others.²⁶ Significant differences in color were found between resin cements and their corresponding shades of cured resin cements when using three different shades of three different brands.²⁷

After selecting the proper shade of resin cement that will produce a pleasing color match with the adjacent teeth, it is important that the color of the final porcelain veneer restoration stay the same after polymerisation of the resin cement. However, it has been demonstrated that a significant change in color may occur during polymerisation of the resin cement and that this should be considered during shade selection and manufacture.²⁸

While visual shade-matching is most practical in a clinical environment, in a laboratory the use of spectrophotometric techniques allows for reliable and reproducible measurements of the color of porcelain.^{29,30} Spectrophotometers measure CIE-LAB values³¹ to give a numeric value of 3D color (E^*) which can then be used to assess color change (ΔE^*).³²

Determining the value of ΔE^* which is clinically significant is challenging and different levels have been determined. It has been shown that the borderline ΔE^* which is perceptible to all people in a color test is 2.5.³³ A scale of perceptible color difference has also been proposed with a $\Delta E^* < 1$ regarded as not appreciable to the human eye and a $\Delta E^* > 2$ appreciable by non-skilled persons and therefore of clinical significance.^{34,35} Moreover, it has been found that 3.3 units of color difference have been considered unacceptable by 50% of observers.³⁶ Similarly, 50% of observers had rejected the color difference of 2.72 ΔE units between the samples.³⁷ Additionally, an *in vivo* study has shown that the average ΔE^* between teeth assessed to be a complete color match intra-orally is 3.7 while the average ΔE^* of 6.8 units has been assessed to present the clinically color mismatch.³⁸ However, a recent *in vivo* study has presented the clinically acceptable threshold to be $\Delta E^* 5.5$ units.³⁹ Therefore, $\Delta E^* 1$ unit and 5.5 units reflects the perceptible and clinically acceptable thresholds respectively, and these values should be borne in mind when assessing restorations spectrophotometrically. It follows, therefore, that if different shades of resin cement produce a ΔE_{ab}^* of this magnitude then a clinically significant difference in the color of the restoration has been achieved.

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