The Effect of Try-In Paste and Resin Cement Shade on Colour Properties of Dental Veneers

Keywords

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ABSTRACT

Objectives: The purpose of this study was to investigate how different shades of try-in pastes, uncured and cured resin cements affect the overall colour of porcelain veneer restorations. Methods: A total of 90 porcelain veneers of shade Vita 1M1 VM7 and 0.6 mm thick were applied to bovine teeth using 3 shades of resin cement and their try-in paste produced by 3 manufacturers. Results: Colour differences produced between the try-in pastes and the corresponding shades of cured resin cements ranged from (ΔE 1.18-3.1). The colour differences between uncured and cured resins of the same shade ranged from (ΔE* 0.78 - 1.41). Conclusions: Different shades of try-in pastes and resin cements produced colour changes which are clinically useful in changing the colour of veneer restorations and therefore assist in colour matching to adjacent teeth. Clinically significant differences were noticed between try-in pastes and the cured resin of the same shade, however, there were relatively small changes measured between un-cured and cured resins. The colour match obtained by the try-in paste has to be treated with caution and further evaluation of the restoration made with the resin in place before curing is recommended.*

INTRODUCTION

Porcelain veneers have many advantages over complete crowns when used to correct dental aesthetic problems, such as tooth discoloration, fracture, deformation and malposition. Veneer restorations have become a common procedure in restorative dentistry, especially after marked improvements have been made in adhesion ability to both enamel and dentin using resin cements.[1]

All porcelain veneers provide some masking of the underlying tooth structure when cemented with a resin composite luting agent.[2] The final colour of a porcelain veneer is determined by several factors which include the colour and the thickness of the porcelain veneer, the thickness and the colour of the luting cement and the colour of the underlying tooth structure.[3,4,5,6] Generally, a relatively thin translucent porcelain veneer cemented to sound tooth could give a good aesthetic result.[7] However, when a porcelain veneer does not produce a good colour 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 shade of the porcelain veneer restoration to achieve a pleasing colour match.[8] However, there is no agreement in the literature about the influence of the cement shade on the overall colour of porcelain veneer restorations or about whether different shades will produce a varied amount of

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colour change of the final restorations, especially when using thin porcelain veneers. Some studies have revealed that the resin cement shade may produce significant colour differences of the final porcelain restorations.[8,9] On the other hand, other studies noticed no significant influences of the resin cement on the overall colour of IPS Empress all-ceramic materials.[3,10] Moreover, colour 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.[11] Similarly, seven different shades of resin cements had no significant effect on the overall colour of porcelain veneers.[12] These different results might be due to the varied experimental methodologies conducted and varied perceptibility and acceptability thresholds used to compare the colour findings.

Vicki, *et al* (2000) revealed that when the thickness was more than 2 mm, the overall colour of IPS-Empress restorations was not influenced by the colour of different substrates.[3] On the other hand, when the thickness of porcelain restoration was less than 1 mm thick, the substrate colour significantly influenced the colour of the cemented restoration.[3,4] It has been demonstrated the L* and a* colour coordinates were affected by ceramic thickness, however, b*value was not influenced by ceramic thickness of two all-ceramic systems.[5] Additionally, it has been demonstrated that changing the thickness of the enamel porcelain will result in considerable changes in different colour parameters.[6] Since the thickness of porcelain has a great effect on the overall colour of completed veneer restoration, clinicians should consider whether tooth anatomy and shade permit to have thin or moderately thick veneers.[4]

The colour of porcelain veneers are, also, related the porcelain material used. Several materials are being used to fabricate ceramic veneers.[5] However, feldspathic porcelain has been widely used to fabricate porcelain veneer and it has continued to be the material of choice in some esthetic cases.

It is generally accepted that an ideal preparation of porcelain veneers is 0.7 mm, reducing to 0.4 mm at the gingival margin 1. However, 24% of teeth prepared to receive a porcelain veneer were found to have preparations of 1.0 mm or more.[7] Moreover, the depth of the preparations of maxillary central incisors prepared to receive porcelain veneers ranged from 0.15-1.2 mm.[8]

Moderately thin veneers are considered to be conservative and aesthetic restorations if the teeth have relatively normal shades and practitioners use try-in pastes before final placement to assess the likely final colour of the completed veneer restoration. Comparing the shade of the try-in paste with the shade of the polymerized resin cement has been suggested to assure that the desired veneer colour is attained.[9,10] Additionally, it has been suggested that a considerable change in colour may take place during polymerization of the resin cement and that this should be kept in mind during shade selection and preparation of the restoration.[11] In a study assessing the effects of resin cement on the final colour of 1 mm porcelain veneer restorations, it was demonstrated that considerable differences were found between the try-in pastes and their related resin cement of three different manufacturers, and very small change in colour happened on polymerization of the resin cement.[12] Although the effect of resin cements on the final colour of porcelain veneers of 1.0 mm thickness were assessed in literature,[12] however, these effects may be greater when using moderately thin porcelain veneers which have higher translucency and can be more easily influenced by the background colour, try-in paste and related resin.

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 colour of porcelain.[16,17] Spectrophotometers measure CIE-LAB values[18] to give a numeric value of 3D colour (E*) which can then be used to assess colour change (ΔE*).[19]

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 colour test is 2.5.[20] A scale of perceptible colour difference has also been proposed with a ΔE* < 1 regarded as not appreciable to the human eye and a ΔE* > 2 appreciable by non-skilled persons and therefore of clinical significance.[21,22] Moreover, it has been found that 3.3 units of colour difference have been considered unacceptable by 50% of observers.[23] Similarly, 50% of observers had rejected the colour difference of 2.72 ΔE units between the samples.[24] Additionally, an in vivo study has shown that the average ΔE* between teeth assessed to be a complete colour match intra-orally is 3.7 while the average ΔE* of 6.8 units has been assessed to present the clinically colour mismatch.[25] However, a recent in vivo study has presented the clinically acceptable threshold to be ΔE* 5.5 units.[26] Therefore, ΔE* 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 colour of the restoration has been achieved.

AIMS OF THE STUDY:

The aim of this study was to assess how different shades of try-in pastes, uncured and cured resin cements influence the overall colour of porcelain veneer restorations (0.6 mm).

The following null hypotheses were investigated;

1. There was no difference between the colour of the try-in paste and the cured resin of the same shade.
2. There was no change in the colour of the restoration on curing of the resin cement.
3. There was no perceptible difference in the colour of the final restoration achieved using different resin cement shades.
4. There was no perceptible difference in the overall veneer colour achieved using different shades of try-in pastes.

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MATERIALS AND METHODS

STUDY DESIGN

A total of 135 bovine teeth were collected, prepared and bleached to standardise colour before random division into 3 groups. Ceramic veneers were produced to a standardised shade and thickness.

Colour was measured with the veneers placed on the prepared surfaces of the teeth with Aquagel acting as a medium between the veneer and tooth (Aquagel is a commercialy water gel: Aquagel® - Adams Healthcare, UK).

One group had veneers bonded with Calibra (Dentsply International), the second with Nexus-3 (Kerr Corporation), and the third with Rely-X (3M-ESPE). Each of the bonded groups was further subdivided into three groups (15 per group) with a light, a dark and a translucent resin selected from those provided by each manufacturer. The veneers were applied to the teeth using the try-in pastes and the colour measured. The veneers were then loaded with resin cement and placed on the prepared tooth surface. Colour was measured pre- and post-curing of the resin. Colour was measured using a spectrophotometer and analysed to determine any differences in the colour of the restorations achieved by the different shades and products produced by each manufacturer.

PREPARATION OF TOOTH SAMPLES

As it considered to be quite similar to the human teeth, bovine central incisor teeth of almost the same size and thickness were used in the study. The teeth had been stored in Thymol solution. Soft tissue was removed manually and then by soaking in 2% sodium hypochlorite (Milton's solution, Milton, UK) for 2 hours. Buccal surfaces were prepared using a circular abrasive lathe in order to produce flattened enamel surfaces of at least 8 mm diameter. The flattened surface was then polished using fine abrasive paper. The teeth were bleached in 33% hydrogen peroxide for 1 hour (2 cycles) in order to standardise the colour by reducing staining. A single operator then recorded a colour reading for all teeth. A specific area of the prepared surface of each tooth was outlined just larger than 8 mm diameter (The diameter of the porcelain veneers used in this study), and colour measurement were performed on this area throughout the whole study to determine standardisation. The teeth were then randomly assigned to the groups and analysed statistically to confirm that there were no significant variations within or between groups.

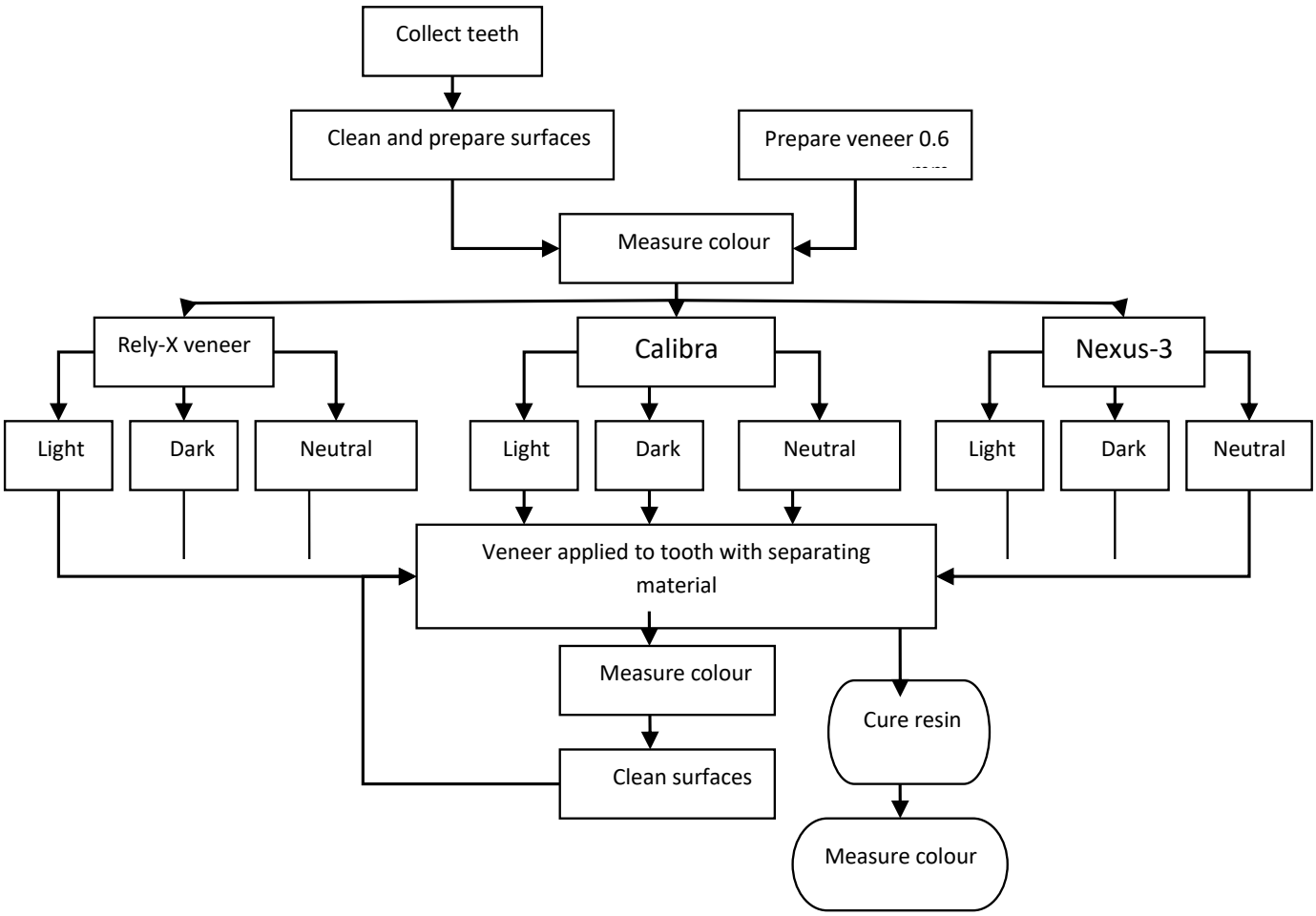

Figure 1: Shows Flow diagram of study design

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PREPARATION OF VENEERS

Vitadur Alpha porcelain veneers of shade 1M1 VM7 (Vita, Zahnfabrik, Bad Sackigen, Germany) were fabricated by a single operator using a Teflon mould with a diameter of 10mm and a depth of 0.7 mm. This shade was selected as such light shades are the most used shades in porcelain veneers fabrication, and mainly the translucency of such light shades enable to assess the effect of resin cement under translucent porcelain veneer shades as translucent shades will be influenced more than the opaque shades. The porcelain and modelling liquid were mixed, packed and dried and then placed onto platinum foil and fired according to manufacturer's instructions. Both surfaces of the veneers were finished using abrasive paper to give a finished thickness of 0.6 mm +/- 0.015mm (measured with digital callipers and rejected if outside given range). A single operator then recorded a colour reading for all veneers to determine standardisation. The veneers were then randomly assigned to the groups.

The bonding surface of each veneer was then prepared by sandblasting and etched with hydrofluoric acid (Vita Ceramic Etch) for 1 minute.

RESIN CEMENTS

Resin cements in the following shades from each stated manufacturer were chosen: Calibra - light, dark, and transparent shades; Nexus-3 Universal Luting system - light, dark and neutral shades; RelyX- Unicem Veneer cement - white opaque, A3 opaque/dark and translucent shades. These shades represent the broadest colour variation available within the shades produced by each manufacturer along with a neutral or translucent resin. The corresponding try-in pastes of each of the above shades were also used.

BONDING

Measurements of colour were taken with each of the different control and test substances (Aqua gel, Try-in pastes, resin cements before curing and resin cements after curing) in place. The tooth and veneer were cleaned and dried before the application of each substance. The try-in paste and resin cements were applied according to the manufacturers' instructions. Teeth surfaces were etched using 37% phosphoric acid that was included with the resin cement kit for 15-20 seconds as instructed by the manufacturer. The resin cement, as instructed, was applied to the etched surfaces of the veneers and then the veneers were applied to the determined area of the teeth surfaces. The resin was then cured with a light-curing unit (Curing light XL3000, 3M ESPE, U.S.A) for 80 seconds to insure complete curing of the cement under such 1 mm porcelain veneers.[40,41]

It has been revealed that the cement thickness can be controlled to a certain extent by the clinician and therefore, it might not be considered as a significant procedure influencing the colour matching process.[14] However, to standardise the thickness of resin cement throughout the whole study, a consistent 1 kg weighed was applied onto the veneer while cementing. A measurement of colour was made before and after the resin cement was cured.

COLOUR MEASUREMENT

Colour measurements were made using an 'Easy shade' Vita probe spectrophotometer (Vita Easy shade, Vita, Germany). Spectrophotometers measure CIE-LAB values giving a numerical representation of a 3D measure of colour. These measurements have been previously used in studies assessing shades of both teeth and porcelain. Readings of L*, a*and b* were performed three times against the same background (black) and the mean value used. Means of colour data with the standard deviations of tooth surfaces, try-in pastes and resin cements are shown in Table 1.

Table 1. Mean ΔE* values produced between different separating materials of porcelain veneers (p-value of 0.05).

		Aquagel Try-in	Aquagel Cured	Try-in Cured	Uncured Cured
Rely-X	White	1.2(0.6-1.9)	1.4(1.1-1.7)	1.2(0.6-1.8)	1.1(0.9-1.4)
	Dark	2.5(1.9-3.2)	3.6(2.8-4.5)	1.8(1.3-2.2)	1.3(0.8-1.7)
	Neutral	1.6(1.2-2)	1.3(1.0-1.6)	1.8(1.5-2.2)	1.4(1.1-1.8)
Calibra	White	2.2(1.3-3)	2.4(1.7-3)	2(1.3-2.7)	1.4(1.3-1.6)
	Dark	3.8(2.9-4.8)	3.2(2.6-3.8)	2(1.3-2.6)	3.3(2.6-3.9)
	Neutral	2.9(2.4-3.3)	2.8(2.1-3.5)	2.4(1.5-3.3)	4.2(3.8-4.7)
Nexus	White	1.4(0.9-1.9)	1.3(1-1.6)	1.3(0.8-1.8)	1.2(0.8-1.6)
	Dark	1.7(0.9-2.4)	2.7(2.2-3.1)	3.1(2.7-3.5)	1.2(0.9-1.5)
	Neutral	1.1(0.8-1.5)	2.4(1.9-3)	2.3(1.6-3)	1.1(0.6-1.7)

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Bovine teeth through the whole study, with or without the porcelain veneers, were stabilised against the black background by holding them on a frame made of impression compound (Kerr, USA) in a way that maintained the veneer in a horizontal level.

DATA ANALYSIS

Data was entered into a Microsoft Excel (Microsoft Corp., Redmond, USA) spreadsheet and analysed using SPSS 15 (SPSS inc., Chicago, USA).

The ΔE* values were calculated for the different shades of cured resin and try-in paste and were also calculated for each resin on curing using the following equation:

$$\Delta E^* = [(L_1^*-L_2^*)2 + (a_1 - a_2)\ 2 + (b_1-b_2)\ 2]^{1/2}$$

The ΔE* values were entered into SPSS 15 to test the null hypotheses that the different shades of try-in paste and cured resin of a manufacturer produce no variation in the colour of the porcelain veneer restorations using analysis of variance ($p<0.05$ and 95% confidence intervals) and Tukey test for multiple comparisons.

An assessment was also made for the clinical significance of colour difference values by comparing them to the perceptibility threshold of 1 ΔE* unit[34] and to the acceptability threshold in clinical situations of 5.5 ΔE* units.[39]

RESULTS:

TRY-IN PASTE AND SAME SHADE OF CURED RESIN CEMENT:

When comparing the final cured resin colour and the try-in paste of the same shade, all shades from each manufacturer produced mean ΔE* values which were perceptible more than 1 ΔE* unit perceptibility threshold (ΔE* ranged from 1.05 – 3.34), but below the clinically significant acceptability threshold of ΔE* 5.5 units *(Figure 2* and Table 1).

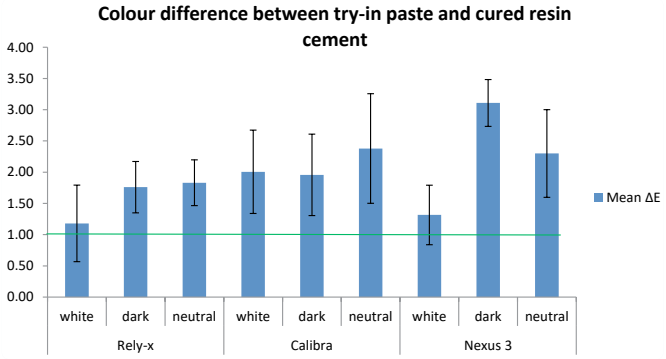

Figure 2: Shows mean ΔE values between try-in paste and resin cement of the same shade (95% Confidence Interval was illustrated) (Green line refers to perceptible threshold).

UNCURED AND CURED RESIN CEMENT:

Mean colour changes on curing of all resin cements were just above the perceptibility threshold (ΔE* 1.1 – 1.4) with the exception of neutral and dark shades of Calibra resin cement where the colour changes were (ΔE* 4.2 and 3.2 respectively) below the acceptability threshold of 5.5 units but, were considerably above the perceptibility threshold of 1 unit *(Figure 3* and Table 1).

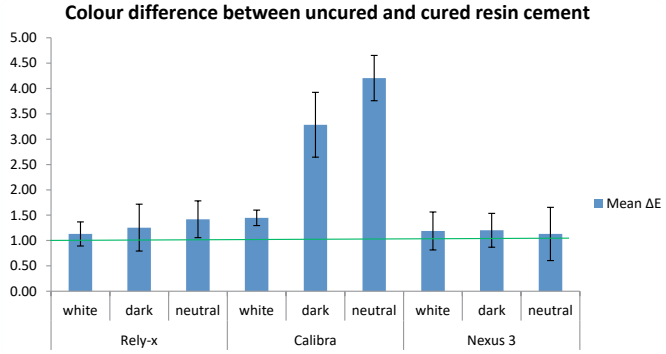

Figure 3: Shows mean ΔE values between uncured and cured resin cement of the same shade (95% Confidence Interval was illustrated) (Green line refers to perceptible threshold).

DIFFERENT SHADES OF CURED RESIN CEMENT:

The ΔE* values produced by resin cements of all shades and manufacturers were between ΔE* 1.3 – 3.6 *(Table 1)*.

There were no significant differences between the ΔE* produced by any of the shades of Calibra resins. Statistically significant differences in ΔE* were produced between aquagel and cured resin shades of both Rely-X Veneer and Nexus 3 *(Figure 4)*. The colour change was significantly different between Rely-X Veneer dark, white resins (mean ΔE* difference = 2.2, p=0.000) and also between dark and neutral resins (mean difference = 2.31, p=0.000). There was a significant difference between Nexus-3 white and dark (mean difference = 1.34, p=0.000) and also between dark and neutral resins (mean difference = 1.12, p=0.002).

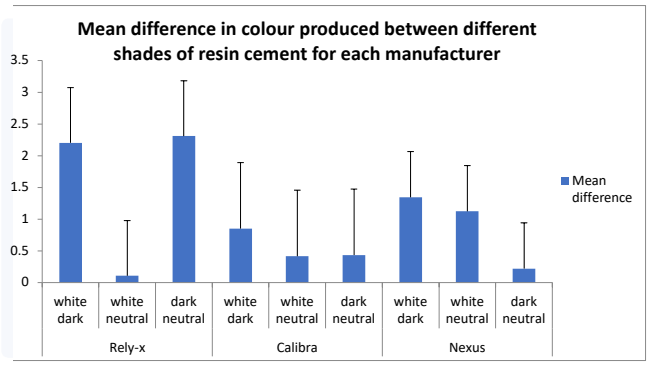

Figure 4: Graph showing mean differences between ΔE values produced between different shades of resin cement of each manufacturer. (95% Confidence Interval was illustrated) (* indicates significance $p<0.05$)

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DIFFERENT SHADES OF TRY-IN PASTES

The Try-in pastes of all shades and manufacturers produced colour changes from the baseline between ΔE* 1.1 – 3.82 *(Table 1)*.

There were no significant differences between the ΔE* produced by any of the shades of Nexus try-in paste. There were significant differences in the ΔE* produced between the white and dark try-in paste shades of Rely-X Veneer (mean difference = 1.29, p=0.004). Calibra Try-in pastes had differences in the ΔE* produced by the dark and white shades (mean difference = 1.67, p=0.006) *(Figure 5)*.

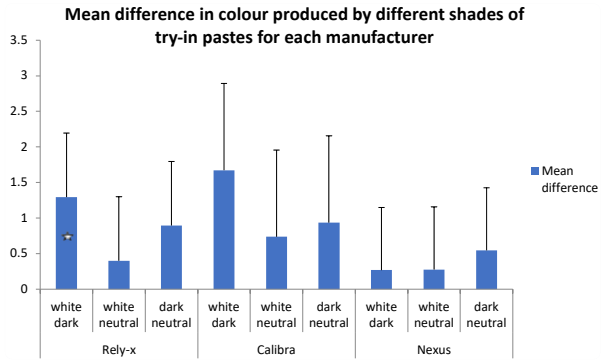

Figure 5: Graph showing mean differences between ΔE values produced between different shades of try-in paste of each manufacturer. (95% Confidence Interval illustrated) (* indicates significance p<0.05).

DISCUSSION:

The null hypothesis that there was no difference between the colour achieved by the try-in paste and the corresponding shade of cured resin cement was rejected since perceptible colour differences were found in all shades and manufacturers. Differences in colour between the try-in pastes and the same shades of resin cements can understandably be traced back to the differences in compositions and therefore in the optical properties between the two materials.

The use of try-in paste is proposed to give an accurate representation of the final colour of porcelain veneer restoration produced using the corresponding shade of resin cement. In other words, the try-in paste is working as a guide to select the shade of resin cement that should give a pleasing colour match between the final porcelain veneer restoration and the adjacent natural teeth. The differences found between the colour of porcelain veneer using the try-in paste and the cured resin cement were in the range (ΔE*=1.18-3.1). These colour differences were below the acceptability threshold, however, they were considerably above the perceptible threshold (ΔE*>1). This implies that the try-in pastes are only useful as a general guide and colour differences between try-in paste and final resin cement may lead to clinically unacceptable differences between the final restoration and the adjacent dentition if care was not observed.

The null hypothesis was that there was no change in the colour of porcelain veneers after curing of the resin cement was rejected as the colour difference between uncured and cured resin cement was perceptible for all shades of resin cement from the three manufacturers used. These differences in colour that happened on polymerization of resin cement might be caused by decreasing the absorption of blue light by photo initiations after light polymerization, which might in turn influence the b* colour coordinates and therefore the final colour of polymerized resin cement.[15] The colour change of resin cement on polymerization were in the range (ΔE= 1.1-1.4) for all shades of Rely X Veneer, Nexus 3 and for the white shade of Calibra. These colour differences are just above the clinically perceptible threshold of 1 ΔE* unit and they are considerably lower than the differences observed between try-in paste and corresponding shade of cured resin cement. Therefore, the uncured resin cement, rather than the try-in paste can act as an accurate guide to select the final cement shade required to attain a pleasing colour match between porcelain veneer restorations and the adjacent teeth. Similar findings where observed in a study where 1 mm porcelain veneers were used.[12] When the porcelain veneer is in place, the final colour can be assessed and the resin cement either removed before polymerization if the colour match is unacceptable, or cured if an acceptable colour match is achieved. And this protocol is almost applicable in clinical situations as it is highly recommended to use light cured resin cements with porcelain veneers rather than dual cured.

However, this is not the case for the dark and neutral shades of Calibra resin cement where the colour difference between uncured and cured resin cements was considerably above the perceptible threshold (ΔE*=3.3 and 4.2 for the dark and neutral shades respectively) but still below the clinically acceptable threshold of 5.5 units. On the other hand, the colour differences between the try-in pastes and resin cement for these two shades were (ΔE* =1.9 and 2.3) respectively, and therefore, using try-in paste rather than uncured resin cement as an accurate guide for the final resin cement shade in case of dark and neutral shades of Calibra resin cement is recommended.

The null hypothesis that there was no perceptible difference in colour of the final restoration achieved using different shades of resin cements produced by a manufacturer was partially rejected and partially accepted. The differences in ΔE* values between dark/neutral and white/dark shades of Rely-X Veneer resin cements, and between white/dark and white/neutral shades of Nexus were statistically significant. No significant differences in ΔE* values were found between different shades of Calibra, between white/neutral shades of Rely-X Veneer and between dark/neutral shades of Nexus 3 resin cements. Differences in colour between different shades of resin cements were caused by different values of a* and b* colour coordinates of different shades based on the fact that resin cements contain some colorants and opacity ingredients in different quantities to produce different shades.

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All shades of resin cement of all manufacturers produced a colour shift from the aquagel baseline in the range of (ΔE*=1.31-3.63), which were significant. These different shades of resin cements may be helpful to reduce below the threshold level the clinically unacceptable or even perceptible colour differences between the restoration and the adjacent teeth. Therefore, resin cement of different shades can be used to act as a guide in order to achieve a clinically pleasing colour match between the porcelain veneer restorations and the adjacent dentition and the same findings were observed in previous study where 1 mm porcelain veneers were used.[12]

The null hypothesis that there was no perceptible difference in colour achieved using different shades of try-in pastes produced by a manufacturer was partially rejected and partially accepted. Statistically significant differences in ΔE* values were found between white/dark shades of Calibra and between white/neutral shades of Rely-X Veneer, while no significant differences in ΔE* values were found between other shades of try-in pastes. The differences between the colours produced by different shades of try-in pastes means that in clinical conditions the different shades can be used to produce different degrees of colour changes and therefore, aid colour-matching process.

The colour of porcelain veneer restorations was influenced by the porcelain thickness along with the brand and shade of the resin cement. For instance, no significant difference in colour was noticed between different shades of Rely-X Veneer resin cements under 1 mm of thick porcelain veneers,[12] while, significant difference was found between white/dark and neutral/dark shades of the same resin cement under 0.6 mm thick of porcelain veneer restorations. Therefore, these factors (shade and brand of resin cement, porcelain thickness) should be considered when matching porcelain veneer restorations with adjacent dentition colour.

CONCLUSION:

The colour of porcelain veneer restorations were influenced by the shade and brand of resin cement, shade and brand of try-in paste and porcelain thickness. Different shades of resin cements produced colour changes, which may be clinically useful in changing the colour of porcelain veneer restorations and therefore aid colour matching process. Significant colour differences were found between try-in pastes and their matched resin cements; and relatively smaller changes were found between un-cured and cured resins for most shades and brands. This suggests that care should be exercised when using a try-in paste to predict the colour of the final restoration and further assessment should be made with the resin in place before curing.

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