Title

An investigation into the effect of try-in pastes, uncured and cured resin cements on the overall colour of ceramic veneer restorations.

Short title

The effect of resin cement on ceramic veneer colour.

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Keywords: Colour difference, resin cement, ceramic veneers.

An investigation into the effect of try-in pastes, uncured and cured resin cements on the overall colour of ceramic veneer restorations.

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 colour of porcelain veneer restorations.

Methods

Porcelain veneers of shade Vita 1M1 VM7 and 1mm thick were applied to bovine teeth using 3 shades of resin cement and their try-in paste produced by 3 manufacturers. Analysis of variance was carried out on the colour 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' colours 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 ($p<0.05$). Colour differences produced between the try-in pastes and the corresponding shades of cured resin cements was perceptible with some of these differences were clinically unacceptable (ΔE* 1.05 – 3.34). The colour differences between uncured and cured resins of the same shade were around the perceptibility threshold (ΔE* 0.78 – 1.41).

Conclusions

Different coloured try-in pastes and resin cements produce colour changes which may be clinically useful in changing the colour of veneer restorations and therefore aid colour matching to the adjacent dentition. The colour match achieved by the try-in paste should be

treated with caution and further assessment of the restoration should be made with the resin in place before curing.

Keywords: Colour difference, resin cement, ceramic veneers.

Article Outline

An investigation into the effect of try-in pastes, uncured and cured resin cements on the overall colour of ceramic veneer restorations.

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, 2, 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 discoloured or malformed anterior teeth has become a popular and standard procedure in aesthetic dentistry [5]. Ninety one per cent 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 colour or shape of anterior teeth such as discoloured 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 colour 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 colour [11]. The shade is then chosen to visually match a shade guide such as the Vita Lumin shade guide tab system (Vita, Zahnfabrik, Bad Sackigen, 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. RelyX- 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 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 [14,15,16,17]. Generally, a relatively thin translucent porcelain veneer cemented to sound non-discolourated tooth could produce a good aesthetic result[18]. However, when a porcelain veneer does not give a pleasing 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 colour of the porcelain veneer restoration to attain a satisfactory colour match[19]. 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 colour change of the final restorations. Some studies have revealed that the resin cement shade may produce significant colour 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 colour of IPS Empress all-ceramic materials [14,21]. 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 [22]. Similarly, seven different shades of resin cements had no significant effect on the overall colour 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 colour findings.

Each of the resins is supplied with a try-in paste to give a visual indication of the colour of the final restoration before final bonding. The stated purpose of these different shades of resin and try in pastes is to improve the colour matching and aesthetics of the final restoration. However, the agreement between the try-in pastes and resin cements in producing the same colour of the final porcelain restoration is critical. Some available brands of the resin cements have try-in pastes which match the colour 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 colour 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 colour match with the adjacent teeth, it is important that the colour of the final porcelain veneer restoration stay the same after polymerization of the resin cement. However, it has been demonstrated that a significant change in colour 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 colour of porcelain[29,30]. Spectrophotometers measure CIE-LAB values[31] to give a numeric value of 3D colour (E*) which can then be used to assess colour 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 colour test is 2.5 [33]. A scale of perceptible colour 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 colour difference have been considered unacceptable by 50% of observers [36]. Similarly, 50% of observers had rejected the colour 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 colour match intra-orally is 3.7 while the average ΔE^* of 6.8 units has been assessed to present the clinically colour mismatch [38]. However, a recent *in vivo* study has presented the clinically acceptable threshold to be ΔE^* 5.5 units [39]. 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.

Aim 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.

The following null hypotheses were investigated:

1. There is no difference in the colour of the final restoration achieved using different shades of luting resin produced by three different manufacturers.
2. There is no difference in the colour achieved using different shades of try-in pastes produced by a manufacturer.
3. There is no perceptible difference between the colour of the try-in paste and the cured resin of the same shade.
4. There is no perceptible change in the colour of the restoration after curing of the resin cement.

2. Materials and methods

2.1 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.

2.2 Preparation of tooth samples

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 8mm 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.

2.3 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 1.2 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 1.0 mm +/- 0.025mm (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.

2.4 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.

2.5 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.

2.6 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.

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.

2.7 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 of the clinical significance of colour differences values by comparing them to the perceptibility (1 ΔE* unit) and acceptability (5.5 ΔE* units) thresholds.

3. Results

3.1 Final restoration

The colour difference of final cured resin restorations was evaluated by comparing the colour change (ΔE*) produced by each resin shade against the Aquagel colour produced by the same tooth veneer complex.

There were no significant differences between the ΔE* values produced by any of the shades of Rely-X resins.

Statistically significant differences in ΔE* were produced between Aquagel and cured resin shades of both Calibra and Nexus (Figure 3).

The colour change was significantly different between Calibra dark and white resins (mean ΔE* difference = 2.13. p=0.000) and also between dark and translucent resins (mean difference = 2.15. p=0.000). There was a significant difference between Nexus-3 dark and neutral resins (mean difference = 1.30. p=0.034).

The ΔE* values produced by all shades of resin were >1 (ΔE* 1.8 – 4.9) and therefore above the perceptible threshold (Table 2).

3.2 Try-in Pastes

The difference in the colour achieved by the different shades of try-in paste was evaluated by calculating the difference in ΔE* between the Aquagel and try-in paste results of each resin shade. The results were tested statistically using analysis of variance.

There were no significant differences between the ΔE* produced by any of the shades of Calibra try-in paste. There were significant differences in the ΔE* produced between the white and translucent try-in shades of Rely-X (mean difference = 1.57. p=0.001). Nexus-3 try-in pastes had differences in the ΔE* produced by the dark and neutral shades (mean difference = 2.09. p=0.000) and also between the white and neutral shades (mean difference = 1.15. p=0.000) (Figure 4).

The Try-in pastes all produced colour changes above the perceptibility threshold of ΔE* 1 unit (ΔE* 0.8 – 3.2) with the Nexus-3 neutral shade <1 and therefore not perceptible (Table 2).

3.3 Try-in paste and same shade of cured resin

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 (ΔE* 1.05 – 3.34) but below the clinically significant threshold of ΔE* 5.5 units (Figure 5).

3.4 Uncured and cured resin

Mean colour changes on curing all resin cements were low (ΔE* 0.78 – 1.41). Some of these colour changes were just above the perceptibility threshold with Rely-X neutral, Calibra dark

and Nexus-3 dark and white shades changed colour by less than the perceptible threshold of 1 ΔE* (Figure 6).

4. Discussion.

The final colour of the porcelain veneer restorations was influenced by the resin cement in terms of shade and brand. All groups produced absolute colour changes between the Aquagel and cured resins which were perceptible (ΔE* > 1).

Significantly differences in colour were found between Calibra dark and neutral shades, Calibra dark and white shades and between the Nexus-3 dark and neutral shades ($p<0.05$). There were no significant differences between colour changes produced by different shades of Rely-X cement. Therefore, the null hypothesis that there is no difference in colour achieved using different shades of resin cement produced by a manufacturer was partially rejected and partially accepted. Differences in colour between different shades of resin cements were understandably noticed as different values of a* and b* colour coordinates of different shades will obviously give different colours based on the fact that resin cements contain some opacity ingredients in different amounts. Moreover, degree of chroma influences the translucency level which in turn influences the final colour as well: high chroma shades were less translucent [42]. However some of these shades might not be different enough resulting in insignificant differences.

Although reasonably low SDs in teeth samples and veneers samples separately were achieved, the SDs were found higher in the complex (tooth, medium and veneer). However, it is a common issue in colour research to find such relatively high SDs, especially with layered samples which might be explained by the variations in colour measurements of samples even under controlled conditions. Moreover, based on sample size calculation made on a similar study, 15 samples were counted per group to minimize the SDs. However, a direct comparison of the colour of final restorations and try-in pastes, and therefore the ΔE between

them, was not performed to avoid such high SD. Alternatively, in comparing the colour differences achieved by the cured resins and the try-in pastes from an Aquagel baseline, it was possible to demonstrate differences in the amount of colour change produced by each shade of resin cement. This does not indicate the final colour of the restoration within the 3D colour space, but relative distances moved within that space (ΔE^*) [32]. It therefore follows that if the distance moved within that colour space is significantly different, then the different shades will produce a different colour of final restoration.

The purpose of the different shades of resin cement is to achieve clinically-acceptable restorations with good colour matching to the adjacent dentition. In the production of the veneer, the porcelain shade is matched to the shade of the adjacent teeth. However, this matched restoration forms a complex with the underlying tooth and this can then have an influence on the colour of the restoration.

The differences between the colour changes produced by different cement shades, although not all above the colour matching threshold, may be sufficient to reduce a clinically-perceptible difference between the restoration and the adjacent dentition to below the clinically perceptible threshold.

The try-in pastes showed significant differences in ΔE^* between white neutral shades of Rely-X, and dark neutral and white neutral shades of Nexus-3. There was no significance in the differences in ΔE^* between different shades of Calibra. Therefore, the null hypothesis that there is no difference in colour achieved using different shades of try-in pastes produced by a manufacturer was partially rejected and partially accepted. The differences between the colours produced by different try-in pastes mean that in a clinical situation the different shades can be used to produce colour changes and guide colour-matching.

The null hypothesis that there is no perceptible difference between the colour achieved by the try-in paste and the same shade of cured resin cement was rejected as all colour difference values between try-in pastes and corresponding shades of resin cements were perceptible

(ΔE* 1.05 – 3.34). All these differences were below the clinically acceptable threshold of ΔE* 5.5 units, however, most of them were highly above the perceptible limit and considered clinically significant.

In order to act as a guide to the shade of resin required to achieve an acceptable restoration, the try-in paste should give an accurate reflection of the final colour which will be achieved by that shade of resin. However, the difference between the try-in paste and the cured resin means that the pastes are only useful as a guide and the difference between that and the cured resin may result in a clinically-unacceptable differences between the restoration and the matched dentition when the cured resin is in place.

The null hypothesis that there is no perceptible change in the colour of the restoration on curing of the resin cement was partially rejected and partially accepted as the ΔE* values calculated between the uncured and cured resin cements for all shades and manufacturers were found to be around the threshold of perceptibility (ΔE* 0.78 – 1.41). Such small colour differences happened on polymerisation of resin cement might be traced back to the reduction in absorption of blue light by photo initiations after light curing, which might influence the b* colour coordinates and therefore the colour difference values [43]. Moreover, resin cements samples became darker after light polymerisation beneath 1mm and 2 mm thick porcelain veneers and therefore, influenced the colour of the final veneer restoration [44].

Colour changes of resin cements on polymerisation were not clinically significant as some these colour change values were just above the perceptibility threshold with Rely-X neutral, Calibra dark and Nexus-3 dark and white shades changed colour by less than the perceptible threshold of 1 ΔE*. Therefore, in a clinical context the guidance of the try-in paste is limited and the colour of the final restoration is more accurately guided by the colour of the uncured resin. When the veneer is in place and the resin is uncured then the colour can be assessed and the resin removed if the colour match is unacceptable. Moreover, using the uncured resin cement is advised to be used as a try-in of porcelain veneers, and using any of the solvents

available for oral use (for instance, acetone, ethanol and methanol) to remove the remains of the uncured resin cement has not influenced the bond strength of these veneers [45].

It is also significant that the thickness of porcelain varies over the area of clinical veneer with thinner porcelain at the cervical margin. The effect of the underlying cement shade would therefore be expected to change over this area. It is generally accepted that an ideal preparation is 0.7mm, reducing to 0.4mm at the gingival margin [8]. Twenty four per cent of teeth prepared to receive a porcelain veneer were found to have preparations around or exceed 1.0 mm [46]. Therefore, porcelain veneers of 1.0 mm thickness were used in this study. And further investigation into the effect of cement shade with 0.6 mm thicknesses of porcelain veneers (1.0 mm, and 0.6 mm will represents the common porcelain thicknesses used to fabricate veneers) is going to be investigated in our next study and this will, it is hoped, add to the overall relevant clinical picture.

The colour of the Empress Porcelain samples cemented with resin cement has changed after water storage, regardless of the shade of resin cement used [47]. Furthermore, many studies have shown a difference in colour of resin cement and porcelain samples after aging [48]. In our study, colour measurements of the veneers were taken after cementation, therefore, further studies are recommended to see the effect of water storage, accelerating aging, and thermocycling on the colour of porcelain veneers cemented by different shades of resin cements.

Additional studies in this area could incorporate clear elements of colour matching. The colour of restoration produced with different resin shades could be compared with the desired shade of porcelain restoration.

5. Conclusion

Different coloured try-in pastes and resin cements produce colour changes which may be clinically useful in changing the colour of veneer restorations and therefore aid colour 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 un-cured and cured resins. The colour match achieved by the try-in paste should be treated with caution and further assessment of the restoration made with the resin in place before curing.

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Tables and Illustrations

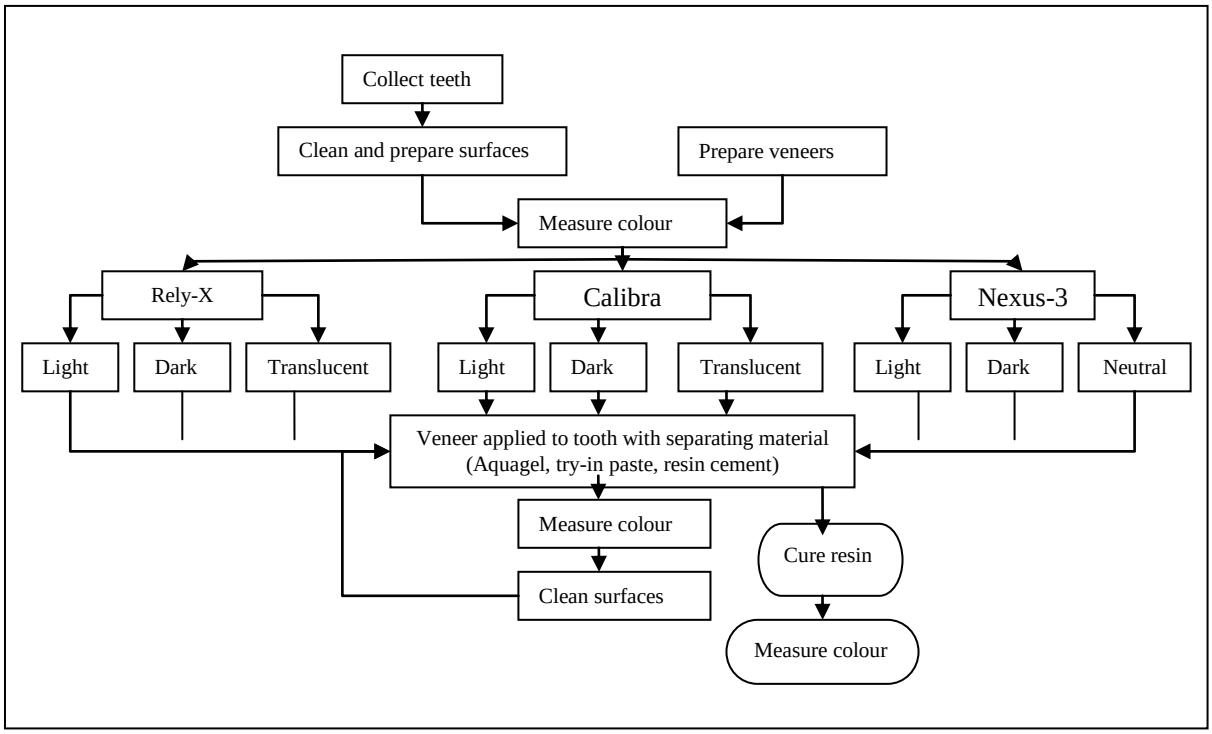

Figure (1): shows Flow diagram of study design

Figure (2): Mould used to make veneers with a porcelain veneer before firing.

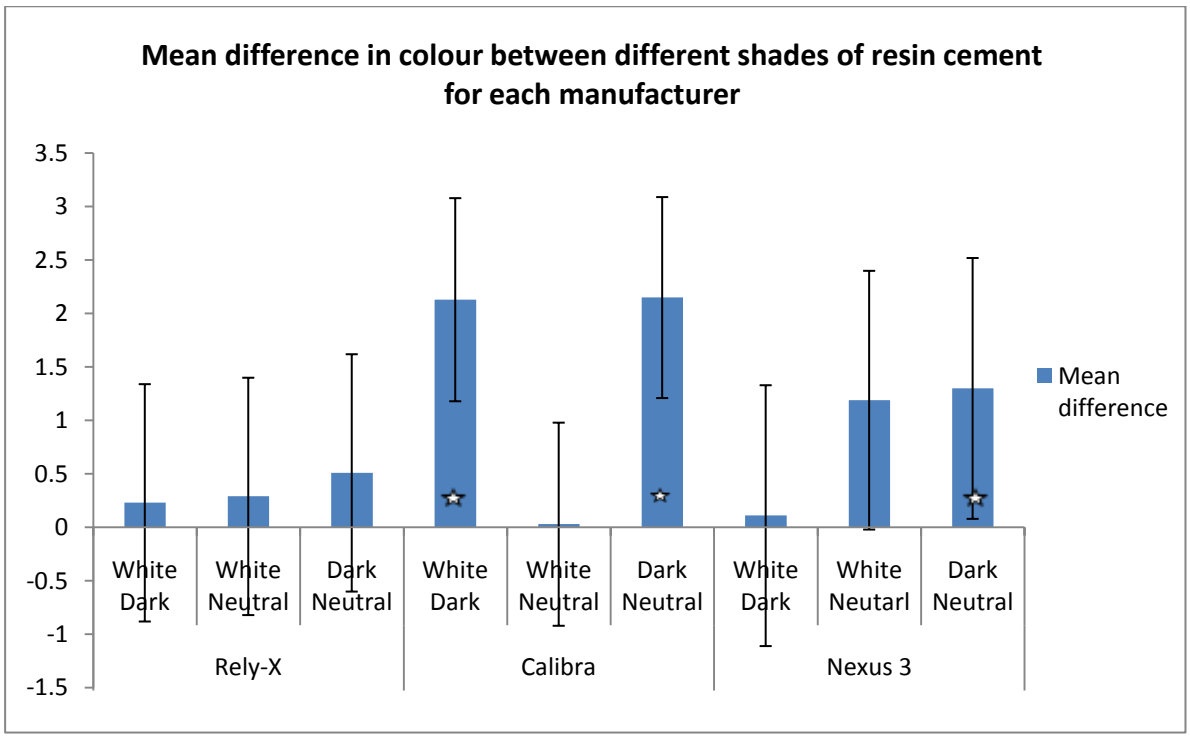

Figure (3) – Graph showing mean differences between ΔE values produced between different shades of resin of each manufacturer. (95% Confidence Interval illustrated)
(* indicates significance p<0.05).

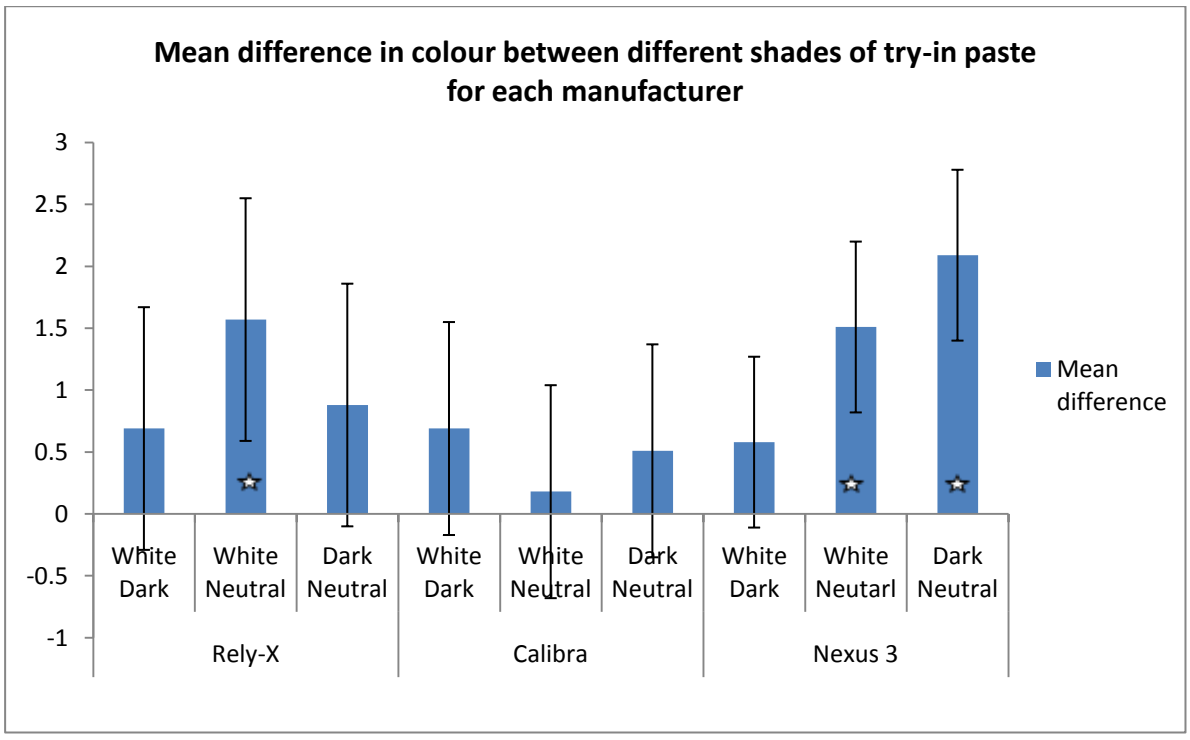

Figure (4) – Graph showing mean differences between ΔE values produced between different shades of try-in paste of each manufacturer. (95% Confidence Interval illustrated)
(* indicates significance p<0.05)

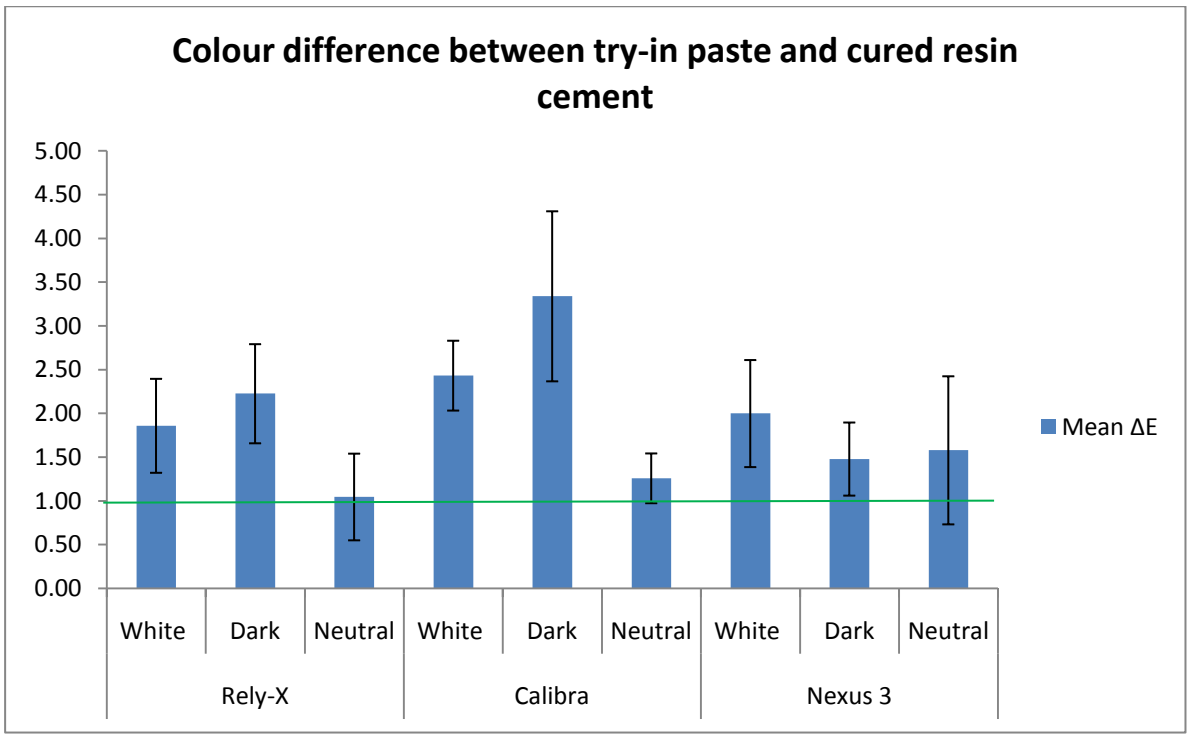

Figure (5) - Mean ΔE between try-in paste and cured resin of the same shade (95% Confidence Interval illustrated) (Green line refers to perceptible threshold, while the red line refers to the clinically acceptable threshold).

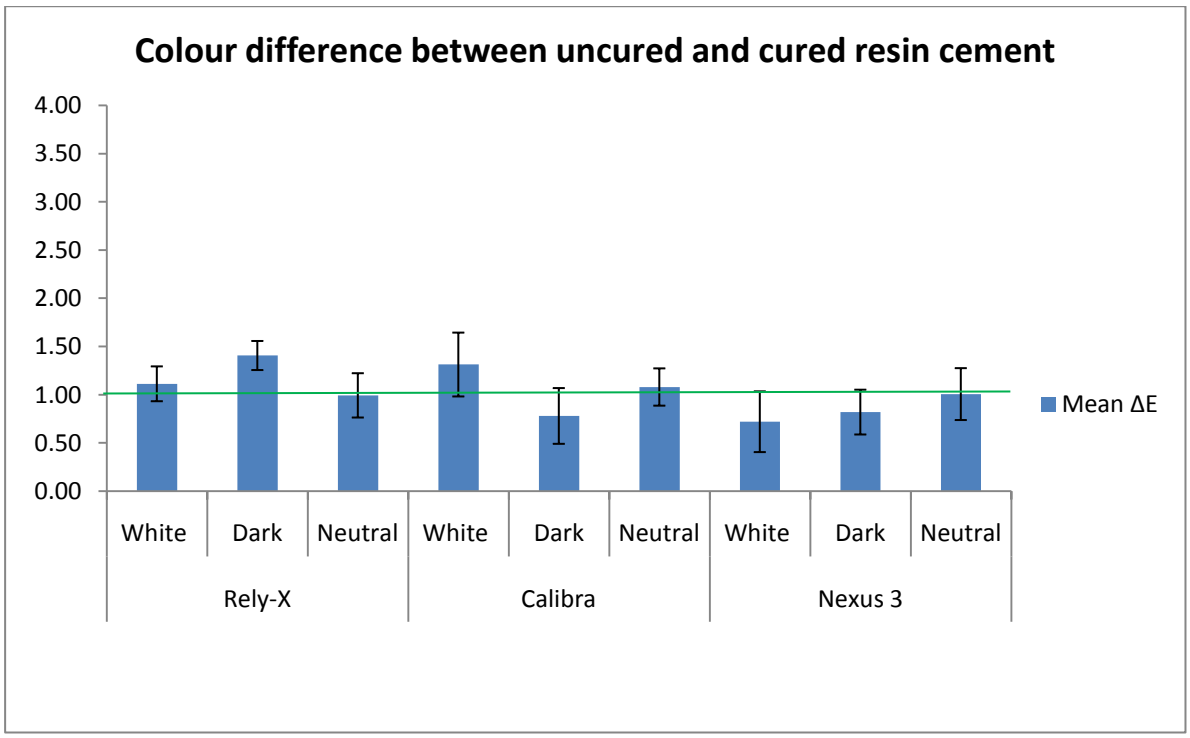

Figure (6) - Mean ΔE between uncured and cured resin of the same shade (95% Confidence Interval illustrated) (Green line refers to perceptible threshold, while the red line refers to the clinically acceptable threshold).

			Teeth surfaces			Try-in pastes			Cured resin cements		
			L*	a*	b*	L*	a*	b*	L*	a*	b*
Rely-x	White	Mean	94.5	-1	14.2	90.6	-0.7	14.4	92.3	-0.8	14.5
		SD	3.3	0.7	2.4	1.5	0.4	0.8	1.5	0.4	1
	Dark	Mean	95.7	-1.2	15.6	91.1	-0.9	16.2	91.2	-0.9	17.9
		SD	2.8	0.4	2.2	2.2	0.3	1.1	1.5	0.4	1.1
	Neutral	Mean	94.5	-1.2	15.6	90.3	-1	14.2	90.8	-1.2	14.5
		SD	3	0.3	2.1	2	0.6	1.5	1.6	0.5	1.1
Calibra	White	Mean	96	-1.2	16.3	90.5	-1	16.2	88.7	-0.4	17.4
		SD	2.7	0.3	2.3	1.8	0.2	1.6	1.5	0.3	1.6
	Dark	Mean	94.8	-1.2	15.7	89.7	-2.6	15.9	90.8	-1.4	18.6
		SD	3.1	0.4	2.9	1.4	0.4	1.3	1.4	0.2	1.4
	Neutral	Mean	94.9	-0.9	16.2	90.6	-0.2	16.3	91.2	-0.8	16.2
		SD	2.2	0.7	2.9	1.8	0.3	1.3	2.1	0.5	1.2
Nexus 3	White	Mean	95.5	-1.3	16.1	90.2	-0.3	15.4	91.2	-0.7	15.5
		SD	3.4	0.3	2.1	1.2	0.3	0.9	2.1	0.4	0.6
	Dark	Mean	95.2	-1	15.8	89.5	0.5	16.6	90.5	0.2	16.7
		SD	2.6	0.5	2.6	1.6	0.4	0.8	1.5	0.3	1.1
	Neutral	Mean	94.5	-1	16.6	90.4	-0.2	15.1	91.2	-0.1	15.5
		SD	3.1	0.7	2.5	1.6	0.3	1.1	1.4	0.4	1

Table (1): Means and SDs of colour data for tooth surfaces, try-in pastes and resin cements.

		Aquagel Try-in	Aquagel Cured	Try-in Cured	Uncured Cured
Rely-X	White	1.6 (1.0)	3.2 (1.2)	1.9 (1.0)	1.1 (0.3)
	Dark	2.3 (0.9)	3.4 (0.9)	2.2 (1.0)	1.4 (0.4)
	Neutral	3.2 (1.4)	2.9 (1.6)	1.1 (0.9)	1.0 (0.3)
Calibra	White	2.1 (0.9)	2.8 (0.5)	2.4 (0.7)	1.3 (0.5)
	Dark	2.8 (0.9)	4.9 (1.3)	3.3 (1.7)	0.8 (0.4)
	Neutral	2.3 (1.1)	2.8 (1.2)	1.3 (0.5)	1.1 (0.6)
Nexus	White	2.3 (0.9)	3.0 (1.7)	2.0 (1.1)	0.7 (0.4)
	Dark	2.9 (0.9)	3.1 (1.0)	1.5 (0.8)	0.8 (0.5)
	Neutral	0.8 (0.5)	1.8 (1.4)	1.6 (1.5)	1.0 (0.6)

Table (2): Mean ΔE values produced between different separating materials (SD).

Legends of tables and Illustrations