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Comparative analysis of color stability of different photoinitiators after polymerization with two curing lights - An invitro study

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Abstract

Photoinitiators are an integral component in light cure composites and their role in the color stability of composites has been established. Commonly used Campheroquinone and also trimethylbenzoylphosphine oxide show some clinical color change post polymerisation . Newer photoinitiator-Ivocerin promises to overcome the problems of these older photo initiators. Additionally they claim to work satisfactorily over a wider wavelength of light cure. Clinically this would be a boon to the dentist and patient in the field of aesthetic dentistry.

The aim of the present study was to evaluate the color stability and color change of ivocerin before and after photo-polymerisation by comparing it with Campheroquinone and trimethylbenzoylphosphine oxide, under a narrow and broad LED wavelength.

Within the limitations of the present study, Ivocerin, shows greater color stability than Campheroquinone and trimethylbenzoylphosphine oxide .

The type of curing light also influenced the outcome, with the Polywave Bluephase curing light showing greater post-cure color stability than the narrow wavelength TulipB100.

This can provide a predictable and more satisfactory results since the color change can be eliminated while planing and implementing aesthetic restorations and can thus be easily implemented clinically,with immediate benefit.

Keywords: Composite, Photoinitiators, Color Stability, Ivocerin, trimethylBenzoylphosphine oxide, campheroquinone., Photo Polymerization, Spectrophotometer,

Introduction

Aesthetic restorations have been sought after since the advent of restorative dentistry, and this aspect of composite restorations has played a major role in its rise and popularity. The ability to match the shade and color of natural teeth is a massive boon to restorative and aesthetic dentistry[1,2]

Tooth-colored restorations frequently experience unacceptable staining or discoloration, which is a major cause for their routine replacement.[3]

Therefore, colour stability is one of the factors contributing to the long-term effectiveness of composite restorations. One of the main considerations when choosing a composite throughout use is colour stability.

The most popular photoinitiator used in dental resin composites that are light-cured is camphorquinone (CQ). However, the dental resin composites' tendency to yellow is linked to this yellowing factor. The yellowing impact of Campheroquinone has prompted manufacturers to include alternate initiators into resin composites to limit the amount of Campheroquinone used, which is a major problem in cosmetic restorative dentistry.[4,5]

other initiators, such as trimethylbenzoyl-diphenylphosphine oxide (TPO) and more recently ivocerin have been tested.The addition of the alternative photoinitiators as a coinitiator lowers the content of Campheroquinone

Ivocerin is a recent advancement, trademarked by the ivoclar vivadent company.

Claimed to have superior color stability and overcome the yellowing effect of Campheroquinone along with more efficient polymerisation.[6]

a relationship between colour stability and conversion rate is established, with incompletely polymerized composite resins showing diminished mechanical qualities and increased sensitivity to discoloration.

This is influenced by the wavelength of the curing light source used.[7]

This study aims to evaluate these factors on the color change of composite in an in vitro setting.

Inorder to eliminate observer bias and human limitations, A spectrophotometer (UV-Vis) is to be employed in order to objectively evaluate any color change and color differences.[8] This study will compare the common photo initiators -Campheroquinone, trimethylbenzoyl-diphenylphosphine

oxide and the newer Ivocerin along with two curing lights with different wavelength ranges.

Material And Method

- Heliomolar (Ivoclar Vivadent) containing campheroquinone. (Figure 1)
- Tetric N-Ceram (Ivoclar Vivadent) containing campheroquinone and trimethylbenzoylphosphine oxide.(Figure 2)
- Tetric Evo Ceram Bulk fill (Ivoclar Vivadent) containing Campheroquinone, trimethylBenzoylphosphine oxide and Ivocerin. (FIGURE 3)
- Tulip 100A curing unit(Figure 4)
- Bluphase N curing unit(Figure 5)

- Teflon moulds (Figure 6)
- Spectrophotometer (UV-Vis)(Figure 7)

The samples from the three groups of composites will then be divided into six sub groups

Each sub-group will consist of 15 samples.(Figure 8) [15 x 2 photo initiators [Curing lights] x 3 composite resins = 90 samples].

Three groups will be cured with the polywave Bluephase N curing unit at an intensity of 1200W/Cm2 for 40 seconds and the other with the conventional monowave curing unit for 40 seconds

The remaing three sub groups will cured with the Tulip100A unit at an intensity oof 1000W/cm2 for 40 seconds each.

The samples will then be Re-tested and color measurements again recorded immediately after polymerization.

The color change Delta E was then calculated and compared between each group.

Statistical Analysis

Descriptive analysis includes expression of Delta E values in terms of Mean & SD for each study group. Kruskal Wallis Test followed by Dunn's post hoc test was used to compare the mean Delta E values between 6 groups. The level of significance was set at $P<0.05$.

Result

Ivocerin containing group,showed a significantly lower Delta E value compared to group containing trimethylBenzoylphosphine oxide , which in turn was lower than that of group containing campheroquinone .

Furthermore, The groups cured with The wider wavelength LED(bluephase) showed lower Delta E values within each group(B<A). Therefore least color change (Delta E) was observed in the group containing Ivocerin cured with Bluephase LED.(table 1)

Discussion

Color stability and color change perceptibility are important factors that affect treatment procedures and outcome.

This is of more importance in composites due to its nature as a direct restorative material .[1,2,3,9]

Tooth-colored restorations frequently experience unacceptable staining or discoloration, which is a major cause for their routine replacement.[2,3]

Therefore, colour stability is one of the factors contributing to the long-term effectiveness of composite restorations. One of the main considerations when choosing a composite throughout use is colour stability.[9]

As the name implies, dental composites are a polymer of numerous components, typically containing, but not limited to ;

Organic Matrix, Filler, Coupling Agent, Activator-Initiator System.The final set material is a polymerised mass composed of the individual monomers.[9]

The color stability is affected by numerous factors, but the major ones are the photo initiators and the curing efficiency, which in turn is affected by the mode and source of light curing.[4,5,9]

The present study is conducted to evaluate the color stability by comparing these factors present in the light curable composites. The market is currently dominated by campheroquinone, and TrimethylBenzoylphosphine oxide. More recently, ivocerin, a proprietary initiator by ivoclar viva dent, claims to have superior qualities which improve its color stability, therefore composites containing these photo initiators were chosen.

Photoinitiators are chemical molecules, which under stimulation of light undergo chemical change resulting in free radicals which initiate and catalyse the reaction within composites. There is exchange of electron in initiator-co-initiator. Due to this process free radicals are

produced through hydrogen abstraction. The initiator molecule becomes a ketyl radical while the co-initiator molecule becomes an amino alkyl radical. The remaining electron of the alkene group reaches the opposite terminal of the monomer and the whole molecule of the monomer becomes a radical. This molecule reacts with another monomer and it results in a chain reaction, which ends when two radicals react with each other[4,9]

in most modern composites 0.1% to 1 wt% of photo initiators are included (The exact values and concentrations are patented by manufactures)

The efficiency and degree of polymerisation is due in large part, to the type of photo initiator system.

This in turn has a bearing on the color stability of the composite as a whole.

Most early forms of dental composites have shown visible and discernible color change prior to and after polymerisation by light activation.

Although the problem of color stability has been largely mitigated, by the alterations in the resin matrix and filler content, the commonly used photo initiators still have a definitive effect on the color stability of light curable composites.

Ivocerin is patented and available only in select products from one manufacturer Vivadent. it is a germanium-based photo initiator and is said to have advantages over the other popular photo initiators.

Ivocerin as a photo initiator have faster, greater polymerization at depth, superior reactivity to curing light having a broad wavelength range of 370nm to 460nm compared to CQ. They have also been demonstrated to have greater degree of conversion of upto 50% greater than CQ.[10]

It is a relatively new compound and due to its claimed benefits and advantages, improving upon the physical properties of composite, particularly the curing efficiency and color stability, this material was chosen in the present study. Ivocerin has low cytotoxicity and no mutagenic effect.

Unfortunately, it has been shown that the peak absorbency wavelength is a very narrow bandwidth for most photo initiators. Therefore it is also important to study the wavelength afforded by commercial curing lights with the composite photo initiators. Therefore the present study looked to compare the effect the wavelength range had on CQ, TPO and Ivocerin.[9,11,12]

Commonly, blue wavelength LED lights are used and this is usually between the wavelength range of 420-480nm.

however, this is clearly not ideal for the commonly used photo initiators - CQ and TPO.

Recently advances have been made on this front with the development of wider wavelength range curing units. One such device is the Blue Phase curing unit by Ivoclar.

In The Present Study Ivocerin containing group showed a significantly lower Delta E value compared to group containing trimethylBenzoylphosphine oxide, which in turn was lower than that of group containing campheroquinone.

Furthermore, the groups cured with the wider wavelength LED (blue phase) showed lower Delta E values within each group(B<A). Therefore, least color change (Delta E) was observed in the group containing Ivocerin cured with Bluephase LED.

Conclusion

Within the limitations of the present study, Ivocerin, showed greater color stability. The present study also analysed the influence of the type of curing light on the

color stability, and found the polywave Bluephase curing light to have a better positive influence on the color stability of all photo initiators used in this study, particularly Ivocerin.

This provides an excellent advantage to the clinician in terms of direct aesthetic restorations,as the shade selection is predictable,as well as the stability of the chosen shade.

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Legend Figures and Tables

Figure 1

Figure 2

Figure 3

Figure 4

Figure 5

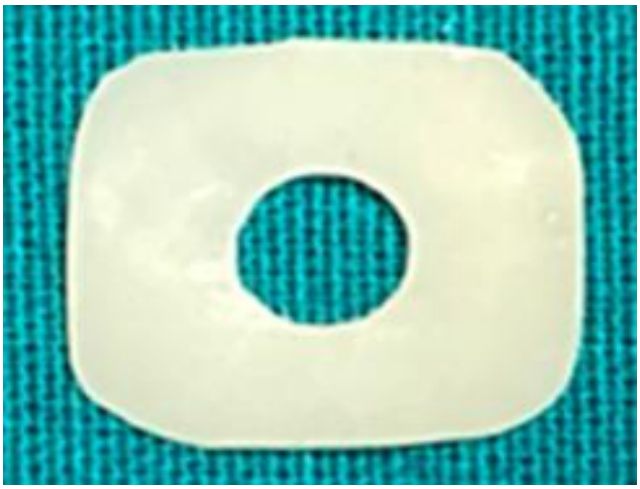

Figure 6

Figure 7

Figure 8

Sl	Delta E Values					
	Group 1A	Group 1B	Group 2A	Group 2B	Group 3A	Group 3B
1	1.572	1.053	1.112	0.695	0.448	0.156
2	1.545	1.389	1.204	0.820	0.644	0.149
3	1.506	1.212	1.232	0.879	0.618	0.025
4	1.554	1.385	1.145	0.965	0.691	0.057
5	1.502	1.333	1.213	0.945	0.808	0.121
6	1.459	1.391	1.154	0.989	0.247	0.021
7	1.526	1.395	1.139	1.099	0.119	0.008
8	1.619	1.371	1.157	0.961	0.291	0.090
9	1.535	1.304	1.135	0.927	0.765	0.066
10	1.709	1.324	1.178	0.986	0.106	0.047
11	1.573	1.365	1.197	0.960	0.095	0.048
12	1.620	1.329	1.157	1.012	0.100	0.066
13	1.604	1.364	1.127	0.853	0.644	0.007
14	1.489	1.327	1.189	1.099	0.691	0.023
15	1.611	1.330	1.152	0.966	0.247	0.006