


OPTICAL PROPERTIES OF CONVENTIONAL COMPOSITE RESINS COMPARED TO MONOCHROMATIC RESINS: A SYSTEMATIC REVIEW OF RANDOMIZED CLINICAL STUDIES

 <https://doi.org/10.56238/arev7n2-274>

Date of submission: 25/01/2025

Date of publication: 25/02/2025

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ABSTRACT

The present work aimed to compare, through a systematic review of randomized clinical studies, the optical properties of monochromatic composite resins in comparison to conventional resins in permanent dentition. The selection of articles was carried out by two researchers independently, in the databases PubMed, Scopus, Web of science, Embase, Cochane and Google Scholar, in addition to a search in the list of references of the selected articles. Initially, articles were selected by title, followed by the summary and finally the full reading of the complete work. 239 articles were selected, after removing duplicates and selection criteria, only 3 articles were included in this review. The articles worked with class IV and class V enamel fractures. The resins used in the articles were different in each study, Admira Fusion X-tra x Admira Fusion; Omnichroma x Tetric-N-Ceram; Universal FiltekX

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Filtek Z350 XT. One study evaluated color matching, stability and marginal discoloration using the USPHS index (Alpha, Bravo and Charlie). The other evaluated color change using a digital spectrophotometer and the other article used modified USPHS criteria and digital photography. The majority of articles presented a low risk of bias and a high level of scientific evidence. It is concluded that the use of monochromatic resins demonstrated a satisfactory effect similar to that regarding color correspondence and stability when compared with conventional resin in classes V and in enamel fractures in class IV.

Keywords: Composite Resin. Monochromatic Resin. Monochromatic Resin. Chameleon Effect. Color. Randomized Clinical Trials.

INTRODUCTION

Composite resins were developed in 1962 [1]. Since then, they have undergone several improvements, such as in 1970 when composite materials polymerized through electromagnetic radiation emerged [2]. Composite resins are the material of choice for performing aesthetic direct restorations [3], and in the dental market, nanohybrid and nanoparticulate resins are available, offering better resistance and favorable aesthetics [2]. Considering that teeth are polychromatic, for these restorations to resemble the natural appearance of teeth, dentists can use the layering technique, applying resins with various shades to achieve a similar color to the tooth's shade [4]. The variety of colors in polychromatic resins can be found within the VITA color scale, which also offers resins for dentin and enamel [4]. Despite satisfactory results, the use of these resins depends on the operator's skill in visual inspection and the application of different resin shades to achieve an aesthetic outcome that closely resembles the dental structure.

As a result, a new type of composite resin has emerged on the market: monochromatic resins, which feature spherical filler particles of uniform size that alter the way light is usually transmitted, enabling the "chameleon effect" [5]. This material comes in a single shade but can blend with 16 shades from the VITA Classical color scale (VITA North America, Yorba Linda, CA). This property allows the resin to exhibit the so-called "chameleon effect," characterized by its ability to mimic the natural color of teeth, regardless of their shade. This results in a shorter operating time for shade selection, lower additional costs—since multiple shades of resin are no longer required for a restoration—and increased patient satisfaction [6]. The chameleon-like mimicking of the resin is achieved through the phenomenon of diffraction, which involves the effect of structural colors. These phenomena are the result of optical diffraction processes in structures that feature nanometric arrangements [7].

A systematic review and meta-analysis of laboratory studies [8] concluded that monochromatic resin showed better results compared to conventional polychromatic resins in terms of color stability and better performance regarding color variation after dental bleaching. However, in terms of color matching, it was concluded that polychromatic resins demonstrated a higher capacity for shade matching compared to monochromatic composites. Therefore, the present study aimed to review the literature and compare the optical properties of monochromatic resins with polychromatic composite resins through a systematic review of randomized clinical trials.

MATERIALS AND METHODS

STUDY DESCRIPTION

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and was registered in the International Prospective Register of Systematic Reviews (PROSPERO; CRD 42024561550). The PICOS question framework was used to formulate this research: In permanent dentition (P), do monochromatic composite resins (I), when compared to polychromatic composite resins (C), show better results regarding optical properties (O) in randomized clinical trials (S)?

LITERATURE SEARCH AND INFORMATION SOURCES

A literature search was conducted in April 2024 using the following databases: PubMed, Scopus, Web of Science, Embase, Cochrane Library, and Google Scholar. A search was also performed on the reference lists of the selected articles. The search strategy used was: (Monoshade OR Single-Shade OR Chameleon OR Group-Shade OR One-shade) AND (Composite resins OR Composite Resin OR Resin Composite OR Composite) AND (randomized controlled trial OR controlled clinical trial OR clinical trial OR RCT OR random allocation OR randomized controlled trial OR controlled clinical trial OR control OR single-blind OR double-blind OR randomized clinical trial).OR clinical trial OR RCT OR random allocation OR randomized controlled trial OR controlled clinical trial OR control* OR single-blind OR double-blind OR randomized clinical trial).

STUDY SELECTION AND ELIGIBILITY CRITERIA

The articles were uploaded to the Rayyan platform, and duplicate removal was performed by two researchers (DRT and JAS). Study selection was independently conducted by two researchers (DRT and JAS), and in cases of disagreement, a third author (JF) was consulted. The process began with a review of the article titles, followed by their abstracts. In the second stage, a full reading of the previously selected studies was performed.

The inclusion criteria consisted of randomized clinical trials that evaluated monochromatic resin in comparison to polychromatic composite resin, regardless of the language or year of publication. Exclusion criteria included in vitro studies, clinical case

reports, review studies, monographs and theses, studies evaluating deciduous dentition, and studies that did not assess optical properties.

DATA EXTRACTION

The data from the selected articles were tabulated using an Excel spreadsheet, with the following parameters: authors/year/country, objectives, evaluation methods, results, and conclusions.

QUALITY ASSESSMENT

Two initial reviewers (AST and DRT) independently assessed the risk of bias. The evaluation process began with the information gathered from the selected articles, in accordance with the Consolidated Standards of Reporting Trials (CONSORT). Data were tabulated following [9] Torres et al. (2023), using established criteria to qualify the methodology across different levels of evidence. The studies were analysed in five domains: sample size, randomization, allocation concealment, blinding, and attrition.

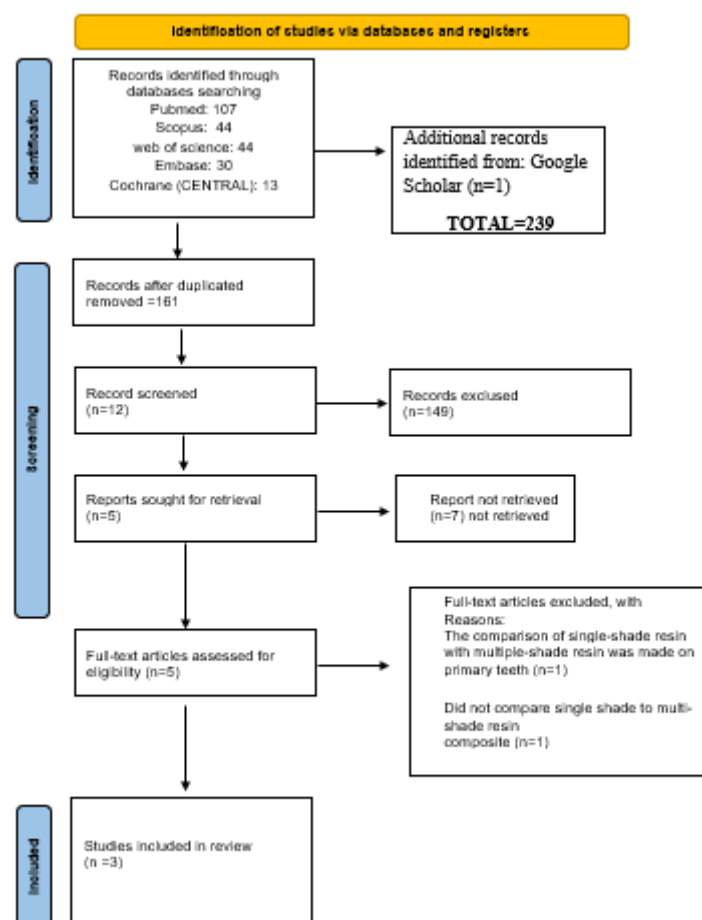
Each criterion was considered adequate (A) if it was reported and explained by the authors. If it was mentioned but not explained, it was rated as B (partially reported). If not mentioned at all, it was marked as C. A clinical trial was classified as Level I evidence if all criteria, or at least four, were marked as A. If the criteria were partially met (with a maximum of two C ratings), the study was classified as Level II evidence. If only two or fewer criteria were met, the study was classified as Level III evidence.

It is important to note that the selected articles included follow-ups, analyses of various types of cavities, and different commercial brands. Due to variations in methodologies and outcomes among the studies, a meta-analysis could not be performed.

RESULTS

A total of 239 articles were selected through the search strategies. After removing duplicates, 117 articles were reviewed based on their titles, followed by their abstracts, and finally the full text. In the end, 3 randomized clinical trials were included in this systematic review, as shown in Figure 1.

Figure 1. Flowchart of the selected article analysis demonstrating the article selection process following PRISMA 2020.



QUALITATIVE ANALYSIS

In the review, 3 randomized clinical trials were selected that evaluated the optical properties of monochromatic resins compared to conventional composite resins [10,11,12]. All of these studies were published recently, in 2023 [10] and 2024 [11,12]. Additionally, two studies were conducted in Egypt [10,11] and one in Brazil [12]. The monochromatic and polychromatic resins used in the studies varied: Admira Fusion and Admira Fusion X-tra [12], Omichroma and Tetric N [11], and Filtek Universal and Filtek Z350 XT [10]. Furthermore, the types of restorations examined in the studies also differed. The characteristics of the selected studies are presented in Table 1.

Table 1. Characteristics of the studies

Author/Year/ Country	Objective	Materials and Methods	Results	Conclusion
MIRANDA et al., 2024 Brazil	To evaluate the color matching of a single-shade composite resin compared to a multi-shade composite resin in restorations of non-carious cervical lesions..	A total of 120 Class V restorations were performed using Fusion Resin and Admira Fusion X-tra Resin. For the evaluation of color matching, a digital spectrophotometer (VITA Easyshade, VITA Zahnfabrik, Bad Säckingen, Germany) was used.	Admira Fusion: Cervical third before and after, after 7 days ΔE_{00} 7.3 ± 4.4 A, Cervical and middle third after 7 days ΔE_{00} 5.5 ± 3.4 A. Admira Fusion X-tra: Cervical third before and after, after 7 days ΔE_{00} 7.2 ± 4.0 A, Cervical and middle third after 7 days ΔE_{00} 5.4 ± 3.8 A.	Single-shade resins show similar values to multi-shade composite resins.
ANWAR et al., 2024 Egypt.	To evaluate the optical behavior and marginal discoloration between a monochromatic resin and a polychromatic resin over 12 months.	Forty restorations were performed on posterior teeth using Omnicroma resin and Tetric-N-Ceram. Color matching, stability, and marginal discoloration were evaluated through visual assessment after 60 minutes, followed by 1, 3, 6, 9, and 12 months, using the USPHS criteria (alpha, bravo, and charlie).	Omnicroma: Initial line 20 (100%) alpha, 1 month 20 (100%) alpha, 3 months 19 (95%) alpha and 1 (5%) bravo, 6 months 18 (90%) alpha and 2 (10%) bravo, 9 months 15 (75%) alpha and 5 (25%) bravo, 12 months 18 (90%) alpha and 2 (10%) bravo, 9 months 15 (75%) alpha and 5 (25%) bravo. Tetric N: All restorations were evaluated as alpha 20 (100%) throughout the entire study period. Marginal discoloration: Both resin groups showed no marginal discoloration – (Alpha at all time points).	Single-shade resins showed comparable performance to the multi-shade nanohybrid composite resin, despite their decline in color stability during the evaluations
HASHEM et al., 2023 Egypt.	To evaluate the color matching potential of the monochromatic layering technique compared to the polychromatic layering technique in the restoration of a fractured incisal edge.	Twenty-six Class IV restorations were performed using Filtek Universal and Filtek Z350XT resin. Color matching was evaluated after 3 days using modified USPHS criteria and digital photography.	Filtek Universal: Modified USPHS - Initial: 13 (100%) B, 3 days: 10 (76.9%) A and 3 (23.1%). Digital photography evaluation: Initial score 3: 3 (23.1%), score 4: 10 (76.9%); after 3 days: score 4: 3 (23.1%), score 5: 10 (76.9%). Filtek Z350 XT: Modified USPHS - Initial: score A 10 (76.9%), score B 3 (23.1%); after 3 days: score A 12 (92.3%), score B 1 (7.7%). Digital photography evaluation: Initial: score 3: 1 (7.7%), score 4: 11 (84.6%), score 5: 1 (7.7%); after 3 days: score 4: 10 (76.9%), score 5: 3 (23.1%).	Monochromatic resins demonstrated satisfactory results regarding color matching in Class IV restorations of enamel fractures compared to conventional resins.

RISK OF BIAS ANALYSIS

The risk of bias was low in all three studies, and all of them presented a high level of scientific evidence, as can be seen in Table 2. All articles included a control group. Randomization occurred in all selected studies, either through a simple method [10], with the aid of a computer [12], or through block randomization [11]. Sampling indices were used in all groups for the sample size calculation. Regarding allocation concealment, only one study mentioned performing it but did not explain how it was carried out [11]. Blinding was done for both evaluators and patients, although blinding the practitioners who performed the restorations was not possible due to the specificities of each material used. None of the articles reported any loss to follow-up. Table 1 shows the risk of bias and the level of scientific evidence for each selected article.

Table 2 - Risk of bias and level of scientific evidence of the articles.

Author/year/ country	Sample size	Randomizatio n	Allocation concealm ent	Masking	Losse s	Level of evidence
Anwar <i>et al.</i> , 2024 Egypt	Yes= A	Yes = A	Yes = B	Yes = A	Yes = A	I
Miranda <i>et al.</i> , 2024 Brazil	Yes = A	Yes = A	Yes = A	Yes = A	Yes = A	I
Hashem <i>et al.</i> , 2023 Egypt	Yes = A	Yes = A	Yes = A	Yes = A	Sim = A	I

Note. Table template reference: Torres et al., 2023.

DISCUSSION

The search for aesthetic restorative materials that allow for shorter working times and present satisfactory optical properties is of utmost importance for dental clinical practice [13]. The present study aimed to compare, through randomized clinical trials, the optical properties of monochromatic composite resins with those of polychromatic resins in permanent dentition.

Randomized clinical trials represent one of the most effective methodologies for obtaining clinical evidence in the health field, fundamentally involving the comparison of two or more interventions, controlled by researchers and applied randomly to a group of participants, to understand the effects of different interventions [14]. Thus, it is considered the second level of scientific evidence for clinical decisions and the gold standard study design for evaluating health interventions [15]. The primary studies analysed [10,11,12] presented a high level of scientific evidence, classified as I, and a low risk of bias in the evaluated categories, thus corroborating the validity of the results of the analysed works.

In the context of Dentistry, where there is a search for aesthetic appearance and restorations that best restore a natural smile, color matching and color stability are important components for evaluating the success of the restorative procedure, especially in areas that require a higher aesthetic appeal, such as anterior tooth restorations [16]. Color matching was evaluated in all studies in different ways [10,11,12], generally yielding satisfactory results regarding the use of these types of resins in different teeth and regions. Notably, the use of a digital spectrophotometer was highlighted, as it allows for objective analysis (through calculations) to measure the optical quality of the resins [17]. However, only one study utilized this method: the work by Miranda et al. (2024), which used the VITA Easyshade equipment. In the other articles, Anwar et al. (2024) employed the USPHS index (Alpha, Bravo, and Charlie), while Hashem et al. (2023) used a modified USPHS and digital photography—a more subjective method that can vary according to daylight and individual differences in color perception [18].

Moreover, due to their optical property of blending with the color of the adjacent dental structure, monochromatic resins facilitate the operator's work, as they are easy to use and reduce clinical time, yielding favorable results [19]. In contrast to the incremental technique, which requires handling different types of shades of conventional composite resins and depends on the operator's skill to achieve a satisfactory result [20]. Thus, the choice of colors relies less on the operator's skill and clinical experience, which is not as critical as when using conventional composite resins.

The study conducted by Basma Badry Hashem et al. (2023) demonstrated the effectiveness of using monochromatic resins in incisal fracture areas. This study showed, through modified USPHS criteria and digital photography, that monochromatic resins can be used in regions requiring a higher aesthetic appeal. It is worth noting that in areas with high aesthetic demand, conventional composite resins are commonly used with different color

combinations to achieve a satisfactory result that replicates the natural appearance of the tooth, which is polychromatic [21].

When used correctly, their application demonstrates excellent clinical success. However, the longer time required for the procedure can be a limitation. Another important point relates to the incisal third, where the individual characteristics of the teeth may necessitate the use of a restorative material with a specific opacity or a combination of shades with two or more opacities, with the thickness of the layers being a significant influencing factor [22].

In dental structures with a certain degree of sclerosis, monochromatic resins showed greater difficulty in masking color, which limits their use and indicates the need for future improvements in the restorative material [12]. Furthermore, as demonstrated in the evaluated studies, monochromatic resins have a variety of applications and locations, in accordance with the studies conducted by Carvalho [23], which highlights their various indications, including restorations of permanent and deciduous teeth, in both anterior and posterior regions, and in different types of cavities.

Color change in composite resins can be caused by a variety of factors, including the matrix of the composite resin, filler weight, particle size distribution, type of photoinitiator used, as well as the nutrition and habits of the individual [24]. Color stability and marginal discoloration were evaluated only in the study by Anwar et al. (2024), where the resins from both studied groups did not show marginal discoloration, thus classified as Alpha throughout the research. In terms of color stability, monochromatic resins received Bravo ratings from the third month of evaluation, while polychromatic resins maintained Alpha ratings throughout all periods. Nonetheless, the single-shade resin demonstrated favorable results comparable to those of the polychromatic resin.

The different types of monochromatic resins, including Filtek Universal [10], Omnichroma [11], and Admira Fusion X-tra [12], used in the evaluated studies highlight the search for improvements regarding this type of restorative material. Despite being recent, these resins have shown positive results in terms of color matching and stability compared to polychromatic resins. Most existing studies are in vitro, and there is a scarcity of randomized studies in the current literature. Nevertheless, the studies conducted on permanent teeth showed satisfactory results in various scenarios, indicating a good future perspective with greater efficiency and wider application of these resins.

Several factors contributed to the limitations of this study, such as high heterogeneity in procedures, varying follow-up times, analysis of different types of cavities, and distinct commercial brands, as well as the low number of available articles on the topic. Therefore, it is difficult to compare studies with different methodologies. This study stands out by generally demonstrating the efficacy of monochromatic resins in randomized clinical studies, serving as an important starting point for conducting further research on the topic, as it is a recent approach.

CONCLUSION

It is concluded that the use of monochromatic resins in the evaluated studies demonstrated satisfactory results in terms of color matching and stability when compared to conventional composite resins, both in Class V restorations and in the treatment of enamel fractures in Class IV and posterior tooth restorations. Despite the scarcity of randomized clinical studies in the literature, all articles selected for this review presented a low risk of bias and a high level of scientific evidence.

STATEMENTS AND DECLARATIONS

All authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

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