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Multicoloured Restorations for Pediatric Dental Patients

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Authors' contributions

This work was carried out in collaboration between all authors. Authors VA and PA designed the study, wrote the protocol, the first draft of the manuscript and managed literature searches. Authors NS and RAT managed the manuscript with critical editing and literature searches. All authors read and approved the final manuscript.

Review Article

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ABSTRACT

The purpose of this review is to discuss the viability of multicoloured dental restorations in children including possible technical, clinical and psychological aspects of multicoloured restorations. Multicoloured restorations utilizing different colours and glitter inclusions are a restorative option within the context of pediatric dentistry. Furthermore, custom shade guides involving different favourite cartoon characters also may improve a child's positive interest in dental treatment. Multicoloured compomers have been available for use in the restoration of deciduous molars since 2002. In contrast to conventional poly-acid-modified resin composites, a small amount of glitter particles are included in order to produce colour effect shades of red, pink, blue, gold, etc. The filler content is similar to conventional compomers. Even though a coloured compomer is made to be decorative, it has physical properties that apparently are sufficient to hold up in the mouth until the restored deciduous tooth is lost. Short-term laboratory studies offer some information about the physical properties of new materials. Nevertheless, long-term clinical studies complement these studies and provide further information regarding the performance of these materials over an acceptable time period.

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1. INTRODUCTION

Early treatment of carious lesions in deciduous teeth is important for the maintenance of oral health. Despite a general decrease in caries, about 30% of all carious lesions apparent in the first dentition of 6-year-olds have not been treated with restorations [1]. One reason for this is that those children who show little or very poor home care compliance are also those who are afraid of dental treatment. It is difficult to motivate these children to receive effective treatment. One way of motivating them is to use multicoloured restorations. Some children prefer tooth-coloured, imperceptible dental restorations, while other children enjoy a colourful restorative material for their deciduous teeth [2]. When it comes to providing an incentive to those children who are nervous and who simply refuse treatment, the deciding factor can be the multicoloured restorations.

Multicoloured compomers (MC) have been available for use in the restoration of deciduous molars since 2002 [3]. In contrast to conventional polyacid-modified resin composites, a small amount of glitter particles are included in order to produce colour effect shades of red, green blue, gold, etc. The filler content and other properties are similar to conventional compomers [4-5]. Though popularly amalgam, GIC and composites have been used for restorations. Amalgam use is discouraged in some countries because of toxicity issues and esthetics. Amalgam is least technique sensitive and microleakage is not a problem because of self-sealing ability.

Even though MC are made to be decorative, they have physical properties that apparently are sufficient to hold up in the mouth until the restored deciduous tooth is lost [5]. Short-term laboratory studies offer some information about the physical properties of new materials. Nevertheless, long-term clinical studies complement these studies and provide further information regarding the performance of these materials over an acceptable time period [6]. The present review discusses all the possible aspects of multi coloured and includes almost all the published research since 2002 till date related to these materials.

2. INDICATIONS AND LIMITATIONS

The indication range of MC includes anterior and posterior restorations of deciduous teeth. Nevertheless, MC are used for the treatment of all types of lesions in the deciduous teeth due to their fluoride-releasing potential, bonding capacity with enamel and dentin and their simple handling properties [4,5].

The use of MC is not possible if a dry working area cannot be achieved. The indicated application technique cannot be carried out if there are known allergies to ingredients.MC must not be used for direct or indirect pulp capping or occlusion-bearing permanent fillings of permanent teeth. Preparations containing eugenol or clove oil disturb polymerization of MC and not to be used with zinc oxide eugenol cements or other materials containing eugenol [4,5,7].

3. ADVANTAGES

1. Giving children a choice of colours can also give them a greater sense of control. It helps to reduce anxiety as it puts colourful fun into the dental process. Children

become more cooperative and less frightened as they feel more involved. Choosing colours makes for an event that leaves a lasting impression. On the next visit, the children often ask or inform the dentist, 'I think I know what colour I want, but I'll have another look just in case I change my mind [8,9].

2. MC demonstrate improved physical, chemical and mechanical properties, and better wear resistance than traditional, reinforced and resin-modified glass ionomers [4,5].
3. MC release fluoride to combat against secondary caries [3,4,5].

4. CHEMICAL COMPOSITION AND PROPERTIES

Multicoloured Polyacid-modified resin composites, commonly called compomers, were developed as direct esthetic restorative materials that combine the desirable properties of light curing composites with those of fluoride-releasing glass ionomer cements [4]. Although MC demonstrate improved properties than glass ionomers, but they are still inferior in these properties compared to conventional resin composites [4,5].

4.1 Magicfil [10,11]

It is a polyacid-modified resin-based composite (compomer). The material polymerizes both by visible light activation and chemical resin curing. While other compomers undergo resin polymerization only by light exposure, this 2-component coloured compomer is blended while being injected through the tip also activating chemical polymerization. The other unique side to this compomer is that the material is manufactured in four bright colours with “glitter” inclusions. The colours are Ocean Blue, Wild Berry, Sunny Yellow, or Cool White Universal shade [3,5]. This dual cured material is composed of BIS GMA based dental resins, additives, pigments, and catalysts. The Fillers are Barium glass and silicon dioxide. Zinc, which is touted as being antimicrobial, is presumably an integral ingredient in the barium glass. The relatively low viscosity is explained by the fact that the material is 63% filled (filler particle size 1um) by weight and 40% by volume compared to around 77% filled for a posterior composite. This will mean that the wear characteristics are not as good as those for composite resin, but in the case of deciduous teeth, this factor is probably not that important as the life span of the tooth is limited. There is a fluoride release as with all compomer materials and with Magicfil, a small release of zinc ions which it is said will add an additional antibacterial action.

The manufacturer lists the following physical properties [5]:

1. compressive strength=200 MPa
2. flexural strength=80 MPa
3. flexural modulus=6.5 GPa
4. setting time (chemical)=4 minutes;
5. setting time (photocuring)=40 seconds.

4.2 Twinky Star [7,11,12]

It is a light-cured, coloured, radiopaque and fluoride-releasing compomer specifically to be used in deciduous teeth. It is available in colours of pink, blue, green, lemon, gold, silver and berry7. Twinky Star contains Bis-GMA, diurethane dimethacrylate, TEGDMA, carboxylic acid modified methacrylate, silicon dioxide, “BHT” and camphoroquinone. Twinky star has filler Barium aluminium fluoro borosilicate glass with dioxide particles and glimmer with a content

of 77.8% w/w; 60.8 v/v and a particle size of 0.7um. All the colours comply with food and cosmetics regulations and are toxicologically irrelevant.

1. Dilatometric polymerization shrinkage is 1.5% after 5 secs, 2.1% after 10 secs, 3.4% after 5 minutes of 40 seconds of curing.
2. Compressive strength is 316 MPa
3. Transverse strength is 116 MPa.
4. Radiopacity is of 220% Al
5. Water absorption is 20.4 ug/ mm3
6. Depth of cure is 2mm
7. Knoop hardness is 37.7

4.3 Composan Glitter

It is a universal light-curing compomer filling material in 6 attractive colours with glitter effect for restorations of deciduous teeth. It is available in colours of pink, blue, green, lemon, gold and orange [9].

Hedzelek W [13] conducted infrared spectroscopic examination of 20 restorative materials and natural teeth. The MC used in this study was Twinky star. This experiment was done for forensic evaluation of these materials on chemical basis and infrared spectroscopy was able to differentiate the materials chemically.

5. TECHNICAL PROFILE OF MC

5.1 Bond Strength

Geserick M, et al. [14] evaluated shear Bond Strength of a coloured compomer (Twinky Star, VOCO, Germany) to deciduous dentin following treatment with carisolv, air Abrasion, Er:YAG Laser and a conventional Bur. Bond strength after air abrasion was significantly higher than the other etched groups. Laser treatment with and without etching gave the lowest bond strength. Etching increased the bond strength in conjunction with Carisolv, air abrasion and the Er-YAG laser but decreased the bond strength in the control group. Air abrasion produced the roughest dentine surface which increased the mechanical retention of the compomer and therefore the shear bond strength. Acid etching increased the bond strength in all experimental groups but lowered the bond strength when a bur was used.

Sari S and Akbay Oba A [15] who evaluated the shear bond strength (SBS) of a multicoloured compomer restorative material Twinky Star (VOCO) to enamel and dentin of deciduous teeth reported mean dentin and enamel SBS values (MPa) of 9.50 and 9.82. They also observed the micromorphology of the debonded surfaces and material-tooth interfaces under a scanning electron microscope (SEM). No significant difference was recorded in the SBS between the enamel and dentin ($p>0.05$). Adhesive and cohesive failures in tooth and material were also recorded. He concluded that Twinky star was found to be a successful adhesive restorative material in term of SBS on dentin and enamel of deciduous teeth.

LI Rui, et al. [16] evaluated the bonding property of new Twinky Star compomer. Shear bond strength evaluation test was done and the fractured surfaces were examined with scanning

electron microscope. The value of shear bond strength of new Twinky Star compomer was 22.741±4.789MPa, and the fracture mode were all mixed fracture.

5.2 Photocuring and Related Parameters

Jafarnia B et al. [17] studied that the differences in light absorption of pigments cause variations in light transmission between the four colours of Magicfil (MF), a dual-cure compomer. No statistical significant difference was found between colours and bonding agent. Light absorption was highest for complementary colours of blue light.

The effect of different curing lights was studied by Ontiveros JC et al. [18] who investigated measurement of depth of cure using Vickers Hardness Number (VHN) to compare different curing lights and various shades of the compomer. Three LED lights [L.E. Demetron (DE), SDS/Kerr; Ultra Lume 5 (UL), Ultradent; The Cure (TC), Spring Health; and 1 QTH unit, Optilux 501 (OP)] were used to cure 3 shades [Green (GR), Gold (GL), and Blue (BL)] of compomer (Twinky Star, VOCO GmbH) and 1 shade (A2) of composite resin (Grandio, VOCO GmbH). The UL curing unit achieved a statistically significantly higher VHN among all the light-curing units. For shade A2, VHN values were significantly higher than other shades, while the GL shade was significantly lower. They concluded that curing depth was significantly affected by shade and type of curing light.

Czarnecka B [19] determined the microhardness of Twinky Star in various colours and effect of maturation in water on microhardness. The study was carried out using material in the colours of Lemon, Pink and Green. Microhardness of the examined material stored in an environment similar to the physiological increased over the course of time. No influence of the material's colour on its microhardness was observed immediately after polymerization. There was an influence of the material's colour on microhardness as a result of the maturation of the compomer stored in water.

Vandenbulcke JD et al. [20] compared the depth of cure (DoC) of a coloured polyacid-modified composite resin Twinky Star (Voco, all shades), with a traditional polyacid-modified composite resin Glasiosite (VOCO), and a fine hybrid composite resin Z100 (3M ESPE) shades A2 and A4 using different light-curing units (halogen based and LED) and different radiant energies. It was revealed that the DoC depended significantly on the shade of the material and the curing device. Moreover, there was a significant interaction between the latter, indicating that the effect of the energy densities differed quantitatively among the shades. Twinky Star shade blue showed the highest DoC compared to Glasiosite and Z100 shades A2 and A4. The curing device with the highest energy density exhibited the highest curing depths. They concluded that coloured compomers could also be a good alternative to tooth-coloured compomers in the restoration of deciduous molars.

5.3 Degree of Conversion (DC)

It is also an important factor to consider as different colours may require different times for same DC. Atabek D et al. [21] evaluated the DC of different coloured compomers and of compomers with various curing times. Significant differences in DC results before and after curing were found among the groups. For all curing times, the silver coloured samples showed the poorest DC results, which ranged from 13% to 18%. Pink and blue shades were having sufficient DC after 40 seconds of curing. It was concluded that DC values of different colours were variable. The material properties could be improved by defining the proper

polymerization time for each colour. Polymerisation time of 40 sec is sufficient for pink and blue shades; lemon, orange, green and gold require more time and silver shade highest.

5.4 Flexural Strength

Tolbert S et al. [22] measured the flexural strength of flowable composites. Matrixx Flow; Revolution, Renamel Flowable, Microfil, Synergy Flow and MagicFil. Revolution and Synergy were significantly stronger than all other materials. Revolution and Synergy Flow have the best overall properties and may be useful in high stress class 2 restorations. Magicfil flexural strength is not sufficient for stress bearing restoration.

5.5 Topical Fluoride Application

The effect of topical fluorides neutral sodium fluoride (NNaF) gel and acidulated phosphate fluoride (APF) gel on the surface roughness of coloured compomer (Twinky Star) was studied by Avşar A and Tuloglu N [23] who compared this with conventional compomer (Compoglass F) and resin-modified glass-ionomer cement (Photac-Fil).

They observed that APF gel application increased the surface roughness of Twinky Star, Compoglass F and Photac–Fil restorations. The surface roughness of Twinky Star and Compoglass F was not significantly affected by application of neutral fluoride gels. SEM observations revealed that the surface micromorphology of Twinky-Star did not differ significantly from that of Compoglass F. Photac–Fil was significantly affected by applications of any of the fluoride gels.

5.6 Fluoride Application

Patir A [24] compared the fluoride release and uptake characteristics of three different polyacid-modified resin composites; Twinky Star (Voco, Cuxhaven-Germany), MagicFil (DMG, Hamburg-Germany) and Dyract Extra (DeTrey Dentsply, Konstanz-Germany). For all tested materials, the greatest amount of fluoride release was observed after the first day of the study but gradually diminished with time. After exposure to NaF solution, all materials were recharged and continued releasing fluoride. There was no significant difference in comparison of the amounts of fluoride released from the materials before and after recharging during the test period. They suggested that these polyacid-modified resin composites can be used especially for children in high risk for caries.

5.7 Microleakage

The sealing ability of a coloured compomer material was compared to regular compomers and glass ionomer cements by Abdullah Al Mushayt [25] through micro-leakage assessment and SEM study of the restorative tooth interface. Recently extracted deciduous teeth received class V restorations using 3 materials; Composan glitter, Compoglass F and Fuji IX. After setting and thermocycling, all specimens revealed good resistance to microleakage especially the compomer materials. It was concluded from this study that the new coloured compomer material showed acceptable sealing ability comparable to that of regular compomer and glass ionomer cement.

5.8 Wear Resistance

Burgess JO et al. [26] measured and compared the wear of 13 composite resins using a modified Leinfelder wear machine : Magicfil (a), TPH (b), Venus (bc), Durafil (bc), Esthetix (bc), Point 4 (bc), Herculite XRV (bc), Supreme (bc), Vitalescence (c), Z250 (c), Renamel (c), Alert (c), Miris (c), and Z100 (c). There were four groupings of the materials with respect to wear volume. Magicfil had the poorest wear resistance (greatest wear volume) among the materials tested and was alone in Group A. Wear varied significantly between restorative materials. Wear resistant materials should be used to help support occlusal contact areas that are to be restored.

5.9 Biocompatibility

Ping C et al. [27] evaluated the biological safety of the new Twinky Star compomer samples were tested with the cytotoxicity test, in vitro hemolytic test and acute general toxicity test. The result of cytotoxicity test shows that the samples had no cytotoxicity. The result of in vitro hemolytic test showed that the hemolytic rates of all samples were lower than 5%. The result of acute general toxicity test showed that all samples have no acute general toxicity. They concluded that Twinky Star compomer possesses good biological safety.

6. PSYCHOLOGICAL ASPECT OF MULTICOLOURED RESTORATIONS

Colour is used for excellent effect in virtually all walks of life and today the more vibrant the colour, the better the result. One only has to look at the amazing increase in sales of mobile phone covers and other designer accessories that appeal to the younger market. Into this category come the adhesive tooth jewellery and other cosmetic items. It seems natural, therefore, that designer restorations should be just around the corner and that is just the case. Multicoloured restorations are a new addition to this trend.

In the field of dentistry, children are special patients in many aspects. Passively sitting idle and waiting for dental treatment is difficult for them by natural. Coloured restorations can be an answer to this problem. Children become more cooperative as they feel more involved and consider this as a playful activity. The option to choose from different colours and glitter inclusions also make this a good option .A custom made shade guide involving different favourite cartoon characters also improves interest of children in dental treatment. The child undergoing treatment gets involved in this playful act and actively waits for the outcome of the treatment.

In a CRA study [28], twenty two American dentists evaluated the clinical application and efficacy of Twinky Star coloured composite. Ninety percent of dentists found that possibility of selecting the colour of composite not only relaxed the children, but also inspired them to have a lasting interest in the condition of their teeth. Rest 10% dentists reported parental disapproval of the colour of composite. The dentists also reported the superior consistency and workability of these compomers.

The visual effect of coloured restorations also improves and encourages oral hygiene awareness. The success of the treatment is aided even further by the dentist's explanation to the children that the fillings will continue to look good as long as the patient properly maintains them. Since the children are usually very proud of their new fillings, the idea is to encourage maintenance, so that by educating both children and parents a significant

improvement in general oral hygiene is achieved. The coloured restorative sparks the interest of children and increases their willingness to cooperate by including them in the treatment process. The decision of what colour the filling should be provides little patients with an active part in the treatment and makes the visit to the dentist a stress-free experience that does not cause fear. The children thus develop a lasting interest in the condition and care of their teeth.

Fishman R, et al. [29] evaluated children's preference for posterior restorations. After viewing photographs of amalgam, composite, coloured compomer and stainless steel crowns; 100 children 5-12 years-old responded to a satisfaction survey. The influence of age, gender and ethnicity was assessed and statistically analyzed. Composite resins were preferred the most and amalgam the least. Caucasians mostly selected composites while African Americans stainless steel crowns. Early interest in coloured compomers was seen in young, males and Caucasians.

The multi-coloured restorations are an effective motivational tool for oral hygiene at home. Children take special care of this tooth and the other tooth surfaces also profit, which ultimately benefits the health of the entire deciduous dentition.

7. CLINICAL TECHNIQUE [3,5]

The technique involves following steps:

7.1 Preparation/Colour Selection

Clean teeth to be treated with fluoride-free cleaning paste. Choose one of the colours indicated in the shade guide. Secure a dry working field.

7.2 Preparation of the Cavity

Principally, only a minimal preparation must be prepared in order to preserve healthy tooth substance. The cavity is prepared in the conventional way for an adhesive restoration. Bevels on the enamel margins are placed where appropriate.

7.3 Cleaning

Remove any residues in the cavity with a water jet. Avoid contamination with blood or saliva after cleaning. Remove any excess water with a faint air jet. Do not over dry the dentine. The dentine surface should be moist but not too wet (wet bonding).

7.4 Pulp Protection

Apply a calcium hydroxide lining in areas close to the pulp.

7.5 Bonding Agents

For optimal adhesion, a dentine/enamel bond should be used according to manufacturer’s instructions after the enamel margins are etched with conventional 36% phosphoric acid and left for 15 seconds, then washed and dried.

7.6 MC Application

Restorations over 2 mm in depth should be applied and cured in layers. Each layer must be polymerised for approx. 40 s. To light-cure this material, the light output should be a minimum of 500 mW/cm2 on halogen polymerization devices and LED devices. Use transparent strips and crowns or light-wedges. Ensure a tight marginal seal. The tip of the light curing device should be held as close as possible to the filling surface.

7.7 Finishing and Polishing

Finishing and polishing (with cooling) can be carried out immediately after removal of the shaping aids (e.g. with ultra-fine diamonds, polishing disks). The filling margin or preferably the entire tooth should be fluoridated as a finishing step.

8. CLINICAL PERFORMANCE

The various studies related to the clinical performance of MC based on published research are discussed.

Croll et al. [5] evaluated a second deciduous molar restored in a 8-year-old girl with coloured compomer (Magicfil), and reported that the restoration was intact and served its purpose 10 months after its placement.

Akbay Oba A et al. [30] conducted a study at University of Ankara, Turkey. 80 restorations were placed in 36 children to treat class II cavities with different shades of Twinky star and examined after 12 months using modified criteria of USPHS for anatomical shape, marginal integrity, marginal discolouration, surface quality, approximal contacts, secondary caries and postoperative sensitivity. Three restorations were replaced after one year. Rest of the restorations exhibited excellent results after 12 months of wear. In addition to this, colour selection was also correlated with sex of the patient. Boys favoured blue colour followed by lemon, silver and gold whereas girls exclusively selected the colour pink followed by silver, lemon, gold and blue.

Ertugrul F et al. [31] evaluated the 12-month clinical performance of conventional (Compoglass F) and coloured (Twinky Star) compomer restorative materials in class II restorations of deciduous molars. 196 restorations were placed in 98 children aged between 5 and 10 years who had bilateral matched pairs of carious posterior class II deciduous molars. A split mouth design was used in which 2 materials (Compoglass F, Twinky Star) were randomly placed on contralateral sides by 3 dentists. At baseline, after 6 and after 12 months, the restorations were evaluated using modified USPHS criteria for: secondary caries, marginal integrity, marginal discolouration, anatomic form and surface texture. The survival rate for twinky star restorations was 93%. Twinky star exhibited slightly better values in all criteria but the difference between the two materials was not statistically significant. They concluded that both conventional and coloured compomer materials are suitable restorative materials for deciduous teeth for at least 12 months. Coloured compomers could also be a good alternative to tooth-coloured compomers in the restoration of deciduous molars.

In a three year clinical study by Sarapulzewa M [32] in Russia 50 children with an average age of 5 years and 8 years participated. 60 class II, 52 class I and 88 post endodontic

restorations were placed and tested according to Ryge criteria after three years. It was concluded that Twinky star coloured restorations exhibited the properties of an effective restoration with respect to stability and longevity after three years.

9. DISCUSSION

Children as patients are a real challenge in the dental surgery. In addition to patience and empathy, an appropriate filling material that is suitable for treating children is needed in this situation that provides for good compliance from the patient and a durable treatment success.

MC have been developed as modern restoratives in glitter-effect colours especially for the restoration of deciduous teeth. In 2002, a new coloured compomer material Magicfil was introduced to the market by Croll for children because of its attractive colours. After that two other MC were launched namely twinky star and composan glitter. A wide range of special colours: gold, pink, blue,silver, Green, Orange, Lemon and Berry are available.The coloured restorative (colour guide in original colours) sparks the interest of children and increases their willingness to cooperate by including them in the treatment process. The decision of what colour the filling should provide little patients with an active part in the treatment and makes the visit to the dentist a stress-free experience that does not cause fear. It is also called as rainbow coloured filling concept [5]. The children thus develop a lasting interest in the condition and care of their teeth.

The multi-coloured restorations are an effective motivational tool for oral hygiene at home. Children take special care of restored tooth and the other tooth surfaces also profit, which ultimately benefits the health of the entire deciduous dentition.Moreover, MC are distinguished by its excellent biocoMPatibility and contribution to the prevention of secondary caries with its supplemental fluoride release [24,27].

Nicholson JW [33] discussed in a review on restorative materials for deciduous teeth that magicfil and twinky star are promising materials and deserve special attention in pediatric restorative dentistry. Clinical studies ranging from 12 months to three years mentioned in this review have shown that commercially available coloured compomers have high clinical success rates which are comparable to other materials, and this makes them a suitable alternative for restoring deciduous teeth in children [5,29-32]. Morever, the technical studies also provide a good basis for these materials to be used clinically in an acceptable manner [14-27].

10. FUTURE PROSPECTIVE AND CONCLUSION

These materials are definitely going to be an exciting option for pediatric patients for whom the colour plays an important role in every walk of their life. Future research is needed for long term durability of theses restorations and more clinical data is required regarding satisfaction with such restorations.

Based on this review, it is concluded that MC could be used as an alternative to tooth-coloured compomers and other restorative materials because of its high clinical success supplemented by technical data to support. Now children can look forward to their dental treatment with a generous sprinkling of sparkle in their restorations.

COMPETING INTERESTS

Authors do not have any financial and personal relationships with other people or organizations including employment, consultancies, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding that could inappropriately influence (bias) our work.

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