Compomers in restorative therapy of children: a literature review

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Objective. The restoration of carious primary teeth plays an underestimated role in paediatric dentistry. This is astonishing for many reasons, not least because many new materials have been introduced in recent years. New or modified techniques and materials, with better aesthetics and flexural properties, allow minimally invasive treatment. A transfer of techniques between different dentitions, however, may be problematic because of both micromorphological differences and compliance. Therefore, this paper deals with options for restoring primary teeth and the early stages of the mixed dentition using polyacid-modified composites, the so-called compomers.

Introduction

Despite an overall caries decline in children, 50–60% of carious primary teeth still remain untreated in 6-year-olds¹. In 3-year-olds, 87% are not appropriately filled². This is astonishing because the importance of early treatment for oral health has been well-established. The success of the state community in Bavaria, Germany, with regard to prophylactic approaches for oral health was re-evaluated in 2004³. Altogether, a positive development in oral health was clearly confirmed. Some 49.6% of 6–7-year-olds exhibited no caries experience, while among 12- and 15-year-olds, the relevant

Methods. Medline and Embase were scanned from 1990 through 2006. Furthermore, a hand-search of nonlisted but peer-reviewed papers was performed. The search items were compomer*, dent*, primary* and deciduous*, which identified 109 relevant publications.

Conclusions. Based on high clinical success rates, compomers are now an effective alternative to other materials for restorative therapy in the anterior and posterior primary teeth. A minimum amount of compliance is still mandatory in order to allow for a few minutes of adhesive pretreatment and layering without contamination. If this is not the case, compomers make no sense. Stainless steel crowns are still the most effective from of restoration for severely decayed primary molars.

figures were 47.7% and 41.9%, respectively. The percentage of children with fillings ranged between 35% and 49%, while the percentages of 6–7-year-old children with untreated caries was still 35.3%. This means that 60% of school children with caries experience revealed untreated carious lesions. Several other Bavarian epidemiological investigations have also proven that caries incidence is strongly correlated with sociodemographic factors. In general, the oral health of children is reported to be better the higher the socioeconomic status of their families¹. A strong polarization of caries was detectable, especially in 12-15-year-olds. To document this, Bratthall inaugurated the so-called 'significant caries index' (SiC)⁴. The World Health Organization (WHO) set a target lowering the SiC for children under the age of 12 years below 3.0 by 2015; however, some countries have already reached this goal⁵. Facing the new WHO criteria, primarily elementary schools $(SiC_{DMF-T} \text{ in } 12 \text{ and } 15 \text{ -year-olds} = 3.66 \text{ and } 15 \text{$

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6.80, respectively) in Bavaria require more prophylactic measures.

Recent data about oral health in children and adolescents have demonstrated a significant caries increase between the ages of 12 and 15 years³. Therefore, early and simple restoration is very desirable, especially for individuals with a high risk of caries.

This review deals with options for restoring primary teeth and the early stages of the mixed dentition using polyacid-modified composites, the so-called compomers.

Materials and methods

Database

Medline and Embase were scanned from 1990 through 2006. Furthermore, a hand-search of German peer-reviewed papers was performed. The search items were compomer*, dent*, primary*, and deciduous*, which identified 109 relevant publications. Abstracts were not considered.

Results and discussion

Compomers in primary teeth

Since their introduction to the market in 1993, the indication range of compomers has also been extended to anterior and posterior restorations of primary teeth^{6,7}.

Adhesion to primary teeth

Only minimal intervention by adhesive dentistry has been recommended for primary teeth since the 1970s⁸. A few problems have been reported with this particular technique, however, when using primary teeth as adhesion substrates. For primary enamel, a superficial 30-100 µm prismless layer has been described as being unsuitable per se for conversion into an etch pattern, as it would be in permanent teeth⁹. This layer becomes thicker from anterior to posterior; however, irregularly spread prisms can sometimes found^{9–12}. In order to achieve an appropriate etch pattern, the prismless enamel has to be removed by bevelling margins (Fig. 1), and the etching time should be 30 s^{13-15} . Longer etching times result in less-effective results because of flattening of the etch pattern. The micromechanical retention is comparable to that in permanent teeth¹⁶ since the surface and, therefore, the etch pattern are subject to a larger variation¹⁷.

Whereas enamel bonding has been thoroughly investigated in adhesive dentistry, the results for dentin bonding are controversial. The mechanisms of dentin bonding have been widely discussed in permanent teeth^{18–20}; however, it is unclear if these results are directly transferable to the primary dentition^{21,22}. This may be of fundamental importance because of morphological differences such as a larger tubular diameter and less mineralization of intertubular



Fig. 1. (a) Bevelled box-only Class II cavity of a primary molar (scanning electron micrograph (SEM), \times 30). (b) At the bevel, 30 s of phosphoric acid etching generates a sufficient etching pattern (SEM, \times 1000). (c) Adjacently, the prismless surface layer is clearly visible (SEM, \times 1000). dentin areas^{23,24}. The reported thicker hybrid layers and the consequently hypothesized inferior penetration are still being advocated to cause a less effective dentin bonding in deciduous teeth^{25–28}.

It has been unanimously stated that adhesive restorations have major advantages with regard to retention rates in comparison to, for example, glass ionomer cements^{29,30}. Within different classes of adhesives, however, the results in the literature are contradictory. It is evident that there are an increasing number of reports that do not confirm better results with multistep adhesives^{31–34}. Similar findings have been found in relation to phosphoric acid etching, which is reportedly less effective in primary teeth than in the permanent dentition^{32,35–37}. Nevertheless, it has been unanimously stated that adhesive restorations always reveal less microleakage than conventional lining methods (i.e. glass ionomer cement or calcium hydroxide liners)^{21,38}. Furthermore, it is evident from the literature that older adhesives, such as Scotchbond 2, are also suboptimal in primary teeth³⁹. Bond-strength evaluations have suggested that filled adhesives can be advantageous^{40,41}. Functional cavity investigations have demonstrated that the potential of compomers combined with simplified adhesives for the restoration of primary teeth is promising³¹. The reason for this may be the easy handling of the Prime & Bond NT self-etch system (Dentsply International, York, PA, USA), which is, according to the manufacturer's directions, applicable without separate phosphoric acid etching for some indications, taking 20-30 s in total. El-Kalla demonstrated good marginal adaptation of several resin composites to primary teeth with and without etching or several resin composites⁴². Furthermore, no difference between NRC (Non-Rinse Conditioner, Dentsply International) or no-NRC groups was evident when Prime & Bond NT was used for bonding over the course of an 18-month clinical trial⁴³.

Another important issue is that the effect of acid on primary dentin is more pronounced than it is on permanent teeth, meaning that a 50% conditioning time is still equally effective^{44,45}.

Investigations of caries-affected primary dentin have demonstrated similar problems to caries-affected permanent dentin; however, adequate bond strengths can also be achieved in such cases^{32,46}. This is also true for bond strengths on dentin after chemomechanical caries removal using Carisolv (MediTeam AB, Göteborg, Sweden) in permanent teeth. For primary dentin, however, bond strengths on sound dentin were affected by the use of chemomechanical treatment fluids^{47,48}.

Primary dentin versus primary dentin

Micromorphological studies generally show that resin–dentin interfaces are thicker in primary dentin, as compared to permanent teeth^{27,28,49}, and lower bond strengths have also been reported^{50–52}. Although differences between the substrates have been reported when multistep adhesives are used, this is not the case when one-bottle adhesives are used³².

Compomers: clinical results

As a result of promising results from preclinical evaluations, compomers have been widely used together with one-bottle adhesives for bonding. Despite being less than perfect, the dentin adhesion of these systems seems to be clinically sufficient for omitting undercuts during preparation⁵³. Furthermore, the use of rubber dam is not a conditio sine qua non for clinical success⁵⁴; however, a contamination-free situation has to be guaranteed for at least the period of performing the adhesive application steps and layering. The importance of this prerequisite has been clearly demonstrated by the high secondary caries rates in children with poor compliance: Andersson-Wenkert et al. reported 12-35% failure rates after 2 years of clinical service, representing a 6-17% annual failure rate, which is very high for this group of materials⁵⁵.

Meanwhile, several clinical studies have been published using compomers. Roeters *et al.* investigated Dyract (Dentsply International) in the course of a prospective clinical trial in Class I and II cavities, and they stated that even solely adhesive preparations without undercuts enable long-term success in the first dentition⁵⁴. The mechanical properties are an improvement on glass ionomer cements, as clinically demonstrated by lower fracture rates. Furthermore, does not wear seem to be critical after 3 years of clinical service. Colour alterations have only been superficially recorded. In primary molars, the pretreatment of enamel without phosphoric acid seems to be sufficient to get retention by use of a one-bottle adhesive only. The omission of conventional cement linings did not cause more postoperative hypersensitivities⁵⁴.

In recent years, split-mouth studies evaluating pairs of restoratives in different quadrants have been also carried out in paediatric dentistry⁵⁶. Although Bürkle *et al.* showed that amalgam is still the most frequently used material in primary molars in Europe, many clinical investigations of primary teeth restorations are available⁵⁷.

Compomers versus amalgam as the previous gold standard

Mass et al. compared 63 Dyract restorations and 44 nongamma-2 amalgam restorations. After 2 years of clinical service, no failures had been detected, leading to the conclusion that Dyract may be recommended as alternative to amalgam in primary molars⁵⁸. Marks et al. reported a 94% success rate for Dyract after 3 years, which is an annual failure rate of 2% and comparable to success rates in permanent teeth. The amalgam used achieved 88% success during the same period⁵⁹. Recent studies have also failed to find significant differences between amalgam and compomers in relation to restoration failures^{60,61}. Despite low failure rates, marginal integrity seems to be different. Duggal et al. saw advantages for Dyract, Kavvadia et al. reported disadvantages for F2000 (3M ESPE Dental Products, St Paul, MN, USA), both compared to amalgam (Duggal et al., 60 pairs of restorations; Kavvadia et al., 75 pairs). Analysing these intensive reports, no differences between amalgam and compomers were found at any time during the period under clinical observation^{60,61}.

Compomers versus glass ionomer cements

Clinical trials with short observation periods did not reveal significant differences from conventional glass ionomers^{62,63}. After 42 months, however, Welbury *et al.* found significant differences in clinical outcomes. Comparing Ketac-Fil (3M ESPE) as conventional glass ionomer cement and Dyract as compomer resulted in success rates of 67% for Ketac-Fil and 91% for Dyract, respectively⁶⁴. The main problems for glass ionomers have been retention losses and fractures in Class II cavities. Clinical trials with viscous glass ionomers (Ketac Molar, 3M ESPE⁶²; Fuji IX, GC America Inc., Alsip, IL, USA⁶³) could not confirm this; however, the observation periods were rather short (12 months). In particular, a study from South Africa involving 401 children suggested that varying conditions in different regions of the country resulted in a 12% annual failure rate, which is by far highest so far documented⁶³.

With regard to resin-modified glass ionomer cements, one study from Denmark found no significant differences between Dyract and Fuji II LC (GC America Inc.), Vitremer (3M ESPE) or Photac-Fil (3M ESPE) after 7 years of clinical service, with a success rate of 82%. Twenty-four per cent of adjacent proximal tooth surfaces had to be restored during the observation period⁵³.

Compomers versus resin composites

A split-mouth comparison between a compomer (Compoglass, Ivoclar Vivadent Inc. Amherst, NY, USA) and a resin composite (TPH Spectrum, Dentply) revealed no statistical difference between the materials under investigation^{65,66}. In both studies, the success rates in 35 children was ~80%. Hse *et al.* compared Dyract and Prisma TPH (Dentsply) and found differences only for the criteria of marginal discoloration and wear, with the compomer being inferior to the hybrid composite resin⁶⁶. It is questionable whether this would still be the case with regard to improved compomer materials.

Compomers in studies without controls

A major aspect for clinical success with compomers in the primary dentition seems to be the correct application protocol of the adhesive. Andersson-Wenckert *et al.* reported an annual failure rate of 11%, mainly as a result of retention loss when the adhesive protocol was uncertain or rubber dam was omitted⁵⁵. On the other hand, several recent studies have confirmed the high potential of compomers, even



Fig. 2. SEMs of resin-dentin interfaces in primary teeth (an all-in-one adhesive was used in both cases): (a) after multiple coatings, the interface is intact; and (b) after only a single application, the interaction has failed.

in patients with high caries risk⁶⁷. In the above study, annual failure rates in caries-risk patients were 2% (Dyract) and 3.5% (Hytac, 3M ESPE).

Most of the published studies clearly demonstrate that compomers are also successful when phosphoric acid etching is not separately carried out^{54,58,64,65,68,69}. Cross-sectional studies have confirmed the positive outcome of compomer materials in the primary dentition⁷⁰. Wendt studied patients from 11 paediatric dentistry clinics and reported a 91% success rate.

It is still not fully understood whether recent all-in-one adhesives also have the potential to guarantee good success rates with compomers in primary teeth⁷¹. Unfortunately, only *in vitro* data have been available to date, and only one study combines the use of an all-in-one adhesive with the use of a compomer (Prompt L-Pop/ Hytac)⁷². With regard to bond strength on enamel and dentin, predominantly lower values were recorded for this group of adhesives (Fig. 2)^{73,74}.

Nevertheless, it should be mentioned here, that Prime & Bond NT is widely and successfully used without a separate phosphoric acid etching step. This means that it has worked as all-in-one adhesive from the beginning.

Experiences with coloured compomer restorations

Coloured compomers have been available for use in the restoration of primary molars for over 3 years⁷⁵. In comparison to conventional polyacid-modified resin composites, a small amount of glitter particles are included (mainly silicates from kali) in order to produce a colour effect in shades of red, blue or gold. Scanning electron microscopic images have revealed large nonsilanized particles that probably make these materials more prone to fracture (N. Krämer, unpublished results). The filler content is comparable to conventional compomers. Clinical experiences are scarce, and therefore, a definitive estimation of these compomers has to be postponed.

Anterior restorations

A significant improvement was expected for anterior teeth compared to conventional glass ionomer cements. The patients of interest include young children with early childhood caries and limited compliance as a result of their age. Valid clinical data are missing, however⁷⁶. In recent literature, one paper deals with compomer buildups after endodontic treatment. After 18 months of clinical service, the success rate was 80%⁷⁸. This result is comparable to resin composite restorations in the first dentition⁷⁹, which reportedly have an 80% retention rate after 3 years.

What this paper adds

compomers in the first dentition.

- This review adds knowledge about the clinical outcome of compomers in primary dentition.
- This paper highlights the possibilities and the importance of adhesive mechanism in primary dentition.

Why this paper is important for paediatric dentistsIt is important that clinicians have a good understanding in the possibilities of adhesive restorative dentistry with

Conclusions

From the data reported in this review, compomers can be recommended as a good alternative to amalgam (Fig. 3)⁶⁷. A minimum amount of compliance is still mandatory in order to allow for a few minutes of adhesive pretreatment of cavities without contamination. If this is not the case, compomers make no sense (Fig. 4), and glass ionomers seem to be appropriate as temporary measures in order to gain some time to improve compliance⁷⁹.



Fig. 3. Compomer restorations (Dyract bonded with Prime & Bond NT without NRC or phosphoric acid) after 4 years of clinical service. The dentin bond is fully intact, while the enamel bond has become negligible over time because no enamel remains occlusally as a result of clinical wear.



Fig. 4. Compomer restoration (Dyract bonded with Prime & Bond NT without NRC or phosphoric acid) after 3 years of clinical service. The compliance of the child was too low to guarantee contamination-free adhesive procedures. The restoration had to be replaced because of secondary caries. The following restoration prevailed until natural exfoliation.

Finally, it should be mentioned that some contraindications exist for every kind of restorative therapy. Thus, for severely decayed primary molars, the stainless steel crown is still the most effective restoration⁵⁶.

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