



# Clinical assessment of class II resin-based composites versus preformed metal crowns performed on primary molars in patients at high risk of caries

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## Abstract

**Aim** To compare class II resin composite with preformed metal crowns (PMC) in the treatment of proximal dentinal caries in high caries-risk patients.

**Methods** The charts (270) of paediatric patients with proximal caries of their primary molars were reviewed. Success or failure of a procedure was assessed using the dental notes. Survival analysis was used to calculate the mean survival time (MST) for both procedures. The influence of variables on the mean survival time was investigated.

**Results** A total of 593 class II resin composites and 243 PMCs were placed in patients ranging between 4–13 years of age. The failure percentage of class II resin composites was 22.6% with the majority having been due to recurrent caries, while the failure percentage of PMCs was 15.2% with the majority due to loss of the crown. There was no significant difference between the MST of class II resin composites and PMCs, 41.3 and 45.6 months respectively ( $p$  value = 0.06). In class II resin composites, mesial restorations were associated with lower MST compared to distal restorations ( $p$ -value < 0.001).

**Conclusions** The MST of resin composites and PMCs were comparable when performed on high caries-risk patients.

**Keywords** Children · Class II resin-based composites · Preformed metal crowns · Primary molars · Caries-risk · Survival time

## Introduction

Proximal caries is prevalent in the primary dentition. Its management ranges from minimally invasive approaches, where dental flossing and application of fluoride varnish is advocated, to more invasive procedures where full coronal coverage is indicated. Traditionally, proximal caries has been treated with either amalgam or tooth-coloured materials. Resin-based composites, with their improved characteristics and pleasing aesthetic outcome, are considered one of the most popular restorative materials (Krämer et al. 2007). However, their clinical efficacy in the management of class II carious lesions in primary molars varies. Results of previous prospective clinical trials showed a favourable 2-year

success rate for their use in primary molar teeth (Barr-Agholme et al. 1991; Fuks et al. 2000). When evaluated over a 6-year period, the success rate of class II resin-based composites was only 38% (Varpio 1985). More recent studies have shown better results with lower failure rates (Attin et al. 2001; Kupietzky et al. 2005).

Preformed metal crowns (PMCs) have been advocated for the restoration of primary teeth with extensive caries, developmental problems, extensive tooth surface loss, following pulpotomy or a pulpectomy procedure and for definitive restorative treatment in children at high risk of caries (Kindelan et al. 2008). The PMC is believed to provide a more durable restoration than other restorative options (Kindelan et al. 2008; Seale and Randall 2015). The reported failure rate associated with PMC is in the range of 2–20% (O’Sullivan and Curzon 1991; Papathanasiou et al. 1994; Tate et al. 2002; Attari and Roberts 2006). When compared with resin-based composites, the available evidence suggests more favourable outcomes with PMCs than with resin-based composites in primary molar teeth (Papathanasiou et al. 1994; Tate et al. 2002; Curzon and Tumba 2006).

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The aim of the present retrospective comparative study was to compare class II resin-based composites with PMCs in the treatment of proximal dentinal caries in patients at high-risk of developing caries.

## Materials and methods

Ethical approval was granted by the Health Sciences Centre Ethical Clearance Committee. Dental charts for paediatric patients attending Kuwait University Dental Centre (KUDC) were reviewed to identify patients who had received class II resin-based composites or PMCs on primary molars in the period from 2009 to 2015. To maintain patient confidentiality, each chart was given an identification number.

### Inclusion criteria

Healthy paediatric patients with proximal dentinal caries in primary molars, assessed from pre-operative charts and bite-wing radiographs, were identified and included.

### Exclusion criteria

Records for patients treated without rubber dam isolation and for uncooperative patients were excluded. Patients' level of cooperation was determined using Wright's classification. Pulpotomised teeth or teeth with a preliminary diagnosis of irreversible pulpitis, defined as teeth with nocturnal pain, spontaneous unprovoked pain, pain not relieved by analgesics, pain on biting, or pain on percussion or palpation were excluded. Teeth with soft tissue swelling, fistula, excessive mobility, radiographic evidence of furcation involvement, and internal or external root resorption assessed from pre-operative bitewing radiographs were also excluded.

### Population attending KUDC

Most patients admitted to KUDC have poor oral hygiene practices and present with high dmft/DMFT scores. In addition, the dietary habits of these patients are poor with frequent snacking of highly cariogenic foods.

### Procedure protocols at KUDC

All procedures were performed by dental students under the supervision of specialist paediatric dentists and according to protocols followed in the KUDC paediatric clinic. All procedures were performed under rubber dam isolation after obtaining adequate analgesia. A class II cavity preparation was initiated with excavation of caries and completed with establishment of an appropriate cavity design for resin-based composites. A protective liner

(Vitrebond™ Liner/Base, 3M-ESPE, St Paul, MN, USA) was placed over deep areas of preparations and PMCs over extensively carious teeth.

## Outcome assessment

Success or failure of a procedure was assessed using the dental notes. Clinical success of both class II resin-based composites and PMCs were recorded when the treated tooth was charted as mobile or lost because of exfoliation. Clinical failure of class II resin-based composites was recorded when post-operative pain of irreversible pulpitis, abscess formation, pathologic mobility, recurrent caries, or a fractured or lost filling was documented. Clinical failure of PMCs, on the other hand, were recorded when post-operative pain of irreversible pulpitis, abscess formation, pathologic mobility, localised inflammation and swelling of the surrounding gingiva leading to removal of the PMC, or a perforated or lost PMC was documented.

## Data extraction

Data collection forms were developed and validated by two specialist paediatric dentists on two separate occasions. There were 50 procedures that were piloted using the developed forms. Information gathered from the pilot study was not included in the main study. Data were extracted by a specialist paediatric dentist.

## Statistical analysis

Data were summarised using descriptive statistics. Survival analysis, using the Kaplan–Meier approach, was used to calculate the mean survival time (MST) in months for both procedures. Comparison of MST between procedures was performed using the log rank test. Variables including gender, age group, type of molar (first vs. second primary molar), tooth arch (maxillary vs. mandibular), tooth quadrant (quadrant 1, 2, 3 or 4), condition of tooth at treatment (caries or previously restored), surfaces affected by caries and indirect pulp treatment performance were also investigated to determine whether they might have affected the MST of each procedure separately. Failure of a procedure was considered the end event for calculation of survival analysis. In cases in which the end event did not occur, such as those that were successful or lost to follow-up, or when the end of the study period had been reached, observations were considered as censored (Friedman et al. 2010). The analysis was carried out using SPSS version 17 software (SPSS Inc., Chicago, IL, USA).

## Results

The charts of 270 patients who were treated during the period from 2009 to 2015 and met the inclusion criteria were reviewed and included in the study. Of these charts, 135 were for boys and 135 were for girls (Table 1). From the 270 patient charts, there were 593 class II resin-based composites and 243 PMCs placed in patients aged 4–13 years (mean 7.7 years, standard deviation 1.6). In the class II resin-based composites group, 382 (64.4%) restorations were placed in patients aged 6–9 years and 344 (58%) were placed on primary second molars. There were 489 (82.5%) resin-based composites that were performed on carious teeth while 104 (17.5%) were performed on previously restored teeth. In the PMC group, 178 (73.3%) were placed in patients aged 6–9 years and 133 (54.7%) that were placed on primary second molars. There were 130 PMCs (53.5%) performed on carious teeth while 113 (46.5%) were performed on previously restored teeth. Conventional glass ionomer cement was used for the cementation of 161 PMCs, one PMC was cemented with resin modified glass ionomer and the cement used was not recorded in 81 cases.

### Fate of restorations

The fate of the class II resin-based composites and PMCs are presented in Table 2. In the class II resin-based composites group, 134 (22.6%) cases failed, 61 (10.3%) were successful, and 379 (64%) were in patients who were lost to follow-up. In the PMC group, 37 (15.2%) cases failed, 30 (12.3%) were successful, and 163 (67.1%) were in

**Table 1** Patient demographics and characteristics of treated teeth

	Class II composites N (%)	PMC N (%)
Procedure performed	593 (100)	243 (100)
Age of patient at restoration, years		
4–6	73 (12.3)	25 (10.3)
6–9	382 (64.4)	178 (73.3)
> 9	138 (23.3)	40 (16.5)
Tooth type		
First primary molar (D)	249 (42)	110 (45.3)
Second primary molar (E)	344 (58)	133 (54.7)
Condition at treatment		
Carious	489 (82.5)	130 (53.5)
Restored	104 (17.5)	113 (46.5)
Indirect pulp therapy performed	21 (3.5)	13 (5.3)

PMC preformed metal crown

**Table 2** Fate of restorations

	Class II composites N (%)	PMC N (%)	p-value
Failed	134 (22.6)	37 (15.2)	0.06
Lost to follow-up	379 (64)	163 (67.1)	
Successful	61 (10.3)	30 (12.3)	
End of study	19 (3.2)	13 (5.3)	
Total	593 (100)	243 (100)	

PMC preformed metal crown

patients lost to follow-up. The Chi square test revealed no statistically significant difference between class II resin-based composites and PMCs with regard to fate in primary molar teeth ( $p = 0.06$ ).

### Reasons for failure

Table 3 summarises the reasons for failure of class II resin-based composites and PMCs. The majority of cases that failed in the class II resin-based composites group (77 [57.5%]) were due to recurrent caries. On the other hand, the main reason for failure in the PMC group (16 [43.2%]) was loss of the crown.

### Survival time

The MST was 41.3 months for class II resin-based composites and 45.6 months for PMCs (Table 4). The log rank test revealed no statistically significant difference in MST between the groups ( $p = 0.06$ ). Figure 1 shows the survival analysis plot for both procedures.

**Table 3** Reasons for failure

Reasons for failure	Class II composites N (%)	PMC N (%)
Necrosis	10 (7.5)	7 (19)
Defective filling/perforated PMC	14 (10.4)	3 (8.1)
Recurrent caries	77 (57.5)	1 (2.7)
Lost restoration	10 (7.5)	16 (43.2)
Fractured	1 (0.7)	0
Localised inflammation	0	2 (5.4)
Symptomatic	6 (4.5)	5 (13.5)
Not recorded	16 (12)	3 (8.1)
Total	134 (100)	37 (100)

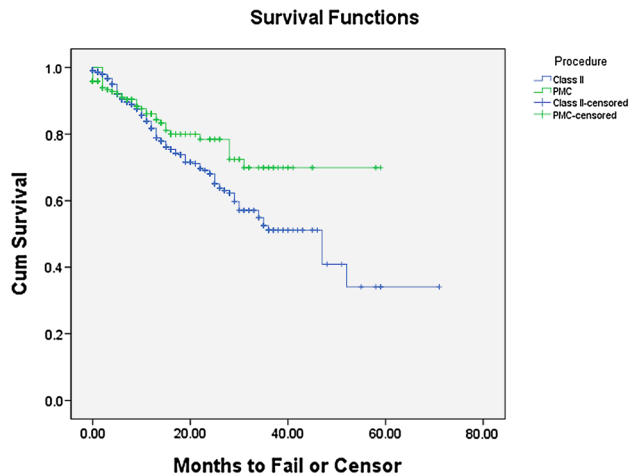
PMC preformed metal crown

**Table 4** Comparison of mean survival time of class II resin composites and PMCs

Class II resin composites				PMC				p-value
N <sup>a</sup> (%)	MST <sup>b</sup>	SE <sup>c</sup>	CI <sup>d</sup>	N (%)	MST	SE	CI	
134 (22.6)	41.3	2.4	36.6–46	37 (15.2)	45.6	2.1	41.6–49.6	0.06

CI confidence interval, MST mean survival time, SE standard error, PMC preformed metal crown

<sup>a</sup>Number of end events; <sup>b</sup>mean survival time (months); <sup>c</sup>standard error; <sup>d</sup>95% confidence interval

**Fig. 1** Survival analysis plot for class II resin composites and preformed metal crowns

### Variables that might have affected MST

Only one variable influenced the MST of class II resin-based composites (Table 5). Mesial restorations had a lower MST than distal restorations ( $p < 0.001$ ). However, all of the investigated variables had no statistically significant effect on the MST of PMCs (Table 6).

### Discussion

This study was a retrospective comparison of the success and survival of class II resin-based composites and PMCs in the treatment of proximal dental caries in high caries-risk patients.

Caution should be exercised when comparing the present study data with those obtained by other investigators, given the difference in study designs, outcome assessment measures and criteria used. In addition, the settings of the other studies varied from academic to general or specialist private practices. The findings of the present study demonstrated a failure rate of 22.6% for class II resin-based composites and 15.2% for PMCs. The documented failure rate of class II resin-based composites in older prospective clinical studies was high and reached up to 62% at 6-year follow-up (Varpio 1985). These poor figures can be attributed to the less

**Table 5** Survival analysis of class II resin composites

Factors	Class II resin composites				p-value
	N (%) <sup>a</sup>	MST <sup>b</sup>	SE <sup>c</sup>	CI <sup>d</sup>	
Gender					
Boys	76 (56.7)	36.3	2.1	32.1–40.5	0.83
Girls	58 (43.3)	42.3	3.7	35.1–49.4	
Age group, years					
4–6	22 (16.4)	43.8	4.1	35.8–51.8	0.10
6.01–9	96 (71.6)	33	1.4	30.2–35.8	
> 9	16 (11.9)	32.8	1.8	29.2–36.4	
Molar type					
First	62 (46.3)	35.9	2.2	31.5–40.2	0.23
Second	72 (53.7)	42	4	34.1–50	
Tooth arch					
Maxillary	72 (53.7)	37.3	2.4	32.6–42.1	0.76
Mandibular	62 (46.3)	40.8	3.1	34.8–46.9	
Tooth quadrant					
1	35 (26.1)	32.5	1.7	29.1–35.8	0.30
2	37 (27.6)	36.9	3	31–42.8	
3	23 (17.2)	41.6	3	35.7–47.4	
4	39 (29.1)	36.3	3.8	28.8–43.8	
Condition at treatment					
Caries	109 (81.3)	43.1	2.5	38.1–48.1	0.25
Restored	25 (18.7)	30.4	2.6	25.4–35.5	
Surfaces affected by caries					
Mesial	110 (82.1)	33	2	29.1–36.9	0.000
Distal	21 (15.7)	52	3.9	44.4–59.6	
Both	3 (2.2)	31.2	4.9	21.6–40.8	

CI confidence interval, MST mean survival time, SE standard error

<sup>a</sup>Number of end events; <sup>b</sup>mean survival time (months); <sup>c</sup>standard error; <sup>d</sup>95% confidence interval

developed adhesives that were used at that time compared to the ones used nowadays. More recent studies have shown better results, with failure rates in the range of 14–29% (O’Sullivan and Curzon 1991; Attin et al. 2001; Kupietzky et al. 2005). On the other hand, the documented failure rate for PMCs in this study is similar to that reported by Papataniassi et al. (1994) where the failure rate for PMCs was 20%. Other studies showed more favourable results with lower failure rates (2–8%) (O’Sullivan and Curzon 1991; Tate et al. 2002; Attari and Roberts 2006). The high failure rate associated with PMCs in the current study can be

**Table 6** Survival analysis of preformed metal crowns (PMCs)

Factors	PMC				p-value
	N (%) <sup>a</sup>	MST <sup>b</sup>	SE <sup>c</sup>	CI <sup>d</sup>	
Gender					
Boys	14 (37.8)	45.7	3	39.8–51.7	0.70
Girls	23 (62.2)	44.8	2.7	39.5–50.2	
Age group, years					
4–6	1 (2.7)	56.6	2.4	52–61.2	0.12
6.01–9	31 (83.8)	34.4	1.7	31.1–37.6	
> 9	5 (13.5)	36.9	3.5	30.1–43.8	
Molar type					
First	16 (43.2)	45	3.1	39–51.1	0.64
Second	21 (56.8)	45.8	2.4	41–50.6	
Tooth arch					
Maxillary	13 (35.1)	46.8	2.9	41.1–52.4	0.29
Mandibular	24 (64.9)	44.1	2.8	38.5–50	
Tooth quadrant					
1	5 (13.5)	47.7	4.1	39.7–55.7	0.57
2	8 (21.6)	31.8	2.3	27.4–36.3	
3	12 (32.4)	35.1	2.6	30.1–40.1	
4	12 (32.4)	42.5	4.3	34.2–50.9	
Condition at treatment					
Caries	17 (45.9)	48.9	2.3	44.3–53.4	0.12
Restored	20 (54.1)	39.6	3.7	32.4–46.9	
Indirect pulp treatment performance					
Performed	3 (8.1)	25.4	4.6	16.3–34.5	0.20
Not performed	34 (91.9)	46	2.1	41.8–50	

CI confidence interval, MST mean survival time, SE standard error

<sup>a</sup>Number of end events; <sup>b</sup>mean survival time (months); <sup>c</sup>standard error; <sup>d</sup>95% confidence interval

explained by the fact that those procedures, although supervised by specialist paediatric dentists, were performed by undergraduate dental students (Chambers 2012). Moreover, it was noted that some of the PMCs were replaced, based on radiographic assessment, because of incorrect fitting, although clinically these PMCs were acceptable. The Chi square test revealed no statistically significant difference between class II resin-based composites and PMCs with regard to fate in primary molar teeth. This result is supported by the results of Hutcheson et al. (2012), where a split-mouth, randomised controlled trial comparing primary molars restored with either a multi-surface composite or PMC revealed comparable successful results for both procedures when assessed clinically and radiographically at the 6- and 12-month recalls. In a retrospective study of records for children attending Leeds Dental Hospital in the UK over a 4-year period, the failure rate of resin-based composites was estimated to be 43% while that of PMCs was 20% (Papathanasiou et al. 1994). In another retrospective study comparing the success rates of PMCs and resin-based composites

placed under general anaesthesia, the overall failure rate of resin-based composites was 30% while that for PMC was significantly lower (8%) (Tate et al. 2002).

Completeness of the follow-up is crucial in any dental restoration study of survival. A large number of restorations lost to follow-up might lead to inaccurate results (Cutler and Ederer 1958). Still, patients may be lost to follow-up for many reasons: they may move, change names, or change dentists. In these cases, the assumption is that restorations lost to follow-up have the same prognosis as those which continue in the study.

The main reason (57.5%) for failure of class II resin-based composites in this study was recurrent caries. This is in agreement with the findings of a randomised clinical trial, where the most common reason for failure (88%) of class II resin-based composites was secondary caries (Bernardo et al. 2007). However, for the PMC group, the main reason for failure (43%) was loss of the PMC. This can be attributed to incorrect preparation of the PMC in treated teeth, where over-reduction of bulbous parts of the primary molar leads to loss of mechanical retention (Savide et al. 1979). Not achieving moisture control during cementation can also be a possible reason for loss of PMCs (Shen 2013). Cementing a large PMC, instead of choosing the smallest size that fits as recommended, can also reduce PMC retention, especially if the gingival margin of the crown is not contoured to adapt to the cervical portion of the tooth (Kindelan et al. 2008).

The most documented reason for failure of PMCs in the literature is gingival bleeding (Ram et al. 2003; Belduz Kara and Yilmaz 2014). In a study by Ram et al. (2003), on comparing the clinical performance of aesthetic crowns with that of conventional PMCs in restoring primary molars, it was noticed that 1 of 10 conventional PMCs showed evidence of gingival bleeding.

There was no significant difference in MST between class II resin-based composites and PMCs (41.3 and 45.6 months, respectively;  $p = 0.06$ ) in the present study. In a report by Atieh (2008), the MST for the PMC group was 23.8 months. In another prospective clinical trial where the survival of resin-modified glass ionomer used in minimal cavity preparations and PMC in primary molars placed in a specialist paediatric dental practice were compared, the survival time for PMCs was reported to be 30 months (Roberts et al. 2005). Papathanasiou et al. (1994) in a retrospective study, estimated the median survival time for PMCs to be more than 5 years while that for resin-based composites was 32 months. In a longitudinal study by Varpio (1985), a median survival time of 40.8 months was documented for class II resin-based composites in primary molars.

The log rank test showed a statistically significant effect of the site of caries in the tooth on the MST of class II resin-based composites. The mesial surface was associated with a shorter MST (33 months) than the distal surface (52 months;



$p < 0.001$ ). Understanding the anatomy of primary molar teeth can help to explain this finding. The primary molars have large pulp chambers with prominent pulp horns, where the mesial pulp horn is higher and closer to the surface than the distal pulp horn (Duggal et al. 2002). Consequently, potential irritants are closer to the pulp tissue on the mesial side than on the distal side. As a result, there is a high chance that failures associated with mesial sides were due to pulpal involvement. In this regard, it is worth noting that 22.4% of failures were due to pulp involvement. Another possible explanation is that students, in order to avoid pulp exposure, were less thorough with caries excavation, leaving caries behind. For the PMC group, there was no statistically significant effect of any of the investigated variables on MST. The fact that the site of caries in the tooth did not influence MST in the PMC group, as it did in the class II resin-based composites group, can be attributed to the sealing ability of the PMC (Ricketts et al. 2006). In agreement with previous reports, gender, age, molar type, tooth arch and tooth quadrant did not influence the survival rate of PMCs or resin-based composites in this study (Drake 1988; Wong and Day 1990; Dawson and Smales 1992; Mjor et al. 2000). In a recent update of a Cochrane review comparing four different approaches (stepwise, partial, no dentinal caries removal and complete caries removal) for management of dentinal caries in previously unrestored primary and permanent teeth, the authors found insufficient evidence to conclude whether there was a difference in signs and symptoms of pulp disease or restoration failure between partial caries removal and complete caries removal techniques (Ricketts et al. 2013). It is important to realise that a student's level of experience, in this study, might have affected the survival time for both procedures.

A limitation of this study is its retrospective design, whereby exposure was assessed from clinical records, and hence a cause and effect relationship cannot be explored.

## Conclusions

Resin-based composites in primary molar teeth, when used under rubber dam isolation in cooperative patients with meticulous application of adhesives was found to be a suitable restorative material in patients at high-risk of caries. This makes resin-based composite a valid alternative option to PMCs in situations where aesthetic demands of parents/patients are high. It was also found that mesially affected tooth surfaces were associated with a lower MST for class II resin-based composites than for the distal surfaces. The majority of failures of class II resin-based composites in the present study were due to recurrent caries, while for the PMCs the failures were due to loss of the crowns.

## Compliance with ethical standards

**Funding** This study was not funded.

**Ethical approval** This article does not contain any studies with human participants or animals performed by any of the authors.

**Informed consent** For this type of study formal consent is not required

**Conflict of interest** Author Alyahya declares that she has no conflict of interest. Author Khanum declares that she has no conflict of interest. Author Qudeimat declares that he has no conflict of interest. AA conceived and designed the study, developed data extraction forms, validated forms, extracted data, and wrote the manuscript; AK identified subjects and records and entered data; MQ helped in designing the study, developing data extraction forms, forms validation, analysed data and reviewed and edited manuscript.

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