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CROSS-SECTIONAL STUDY

Retrospective Evaluation of the Clinical Outcomes and Patient and Parental Satisfaction with Resin Strip Crowns in Primary Incisors

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Abstract: ***Purpose:*** *The purpose of this study was to evaluate the clinical outcomes of resin strip crowns (RSCs) and assess parental and patient satisfaction with RSCs in restoring primary incisors.* ***Methods:*** *The esthetic, functional, and biological properties of RSCs were evaluated using FDI World Dental Federation criteria. Parental and patient satisfaction with RSCs was assessed using interviews. The outcomes were compared between three follow-up periods: 12 to 18, 19 to 24, and 25 to 33 months.* ***Results:*** *Seventy-two RSCs in 41 patients were evaluated after an averagefollow-up period of 21.7 months. Most RSCs were clinically acceptable esthetically (79.2 percent) and biologically (84.7 percent) but unacceptable in function (52.8 percent). Parental satisfaction with esthetics was lowest (55.6 percent), while parental satisfaction with functional and biological properties was high (84.7 percent and 93.1 percent, respectively). Overall parental and patient satisfaction with RSCs was high (90.2 percent and 75.6 percent, respectively). Clinical outcomes and satisfaction scores were lower for RSCs with longer follow-up periods.* ***Conclusions:*** *Resin strip crowns were clinically acceptable for restoring primary incisors, with sufficient esthetic and biological properties, but were deficient in function, especially with longer follow-up periods. Overall parental and patient satisfaction with RSCs was high, in spite of parents having low satisfaction with the esthetics of the RSCs.* *(Pediatr Dent 2018;40(7):425-32) Received June 7, 2018 / Last Revision September 28, 2018 / Accepted October 2, 2018*

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The resin strip crown (**RSC**) was introduced in 1979 for restoring primary anterior teeth using celluloid crown forms and composite resin.[1-3] Other esthetic options for full-coverage restorations in primary incisors include the open-faced stainless steel crown (**SSC**), polycarbonate crown, Pedo Jacket crown, preveneered SSC, and zirconia crown.[4-8] Few studies have compared the superiority of one type of crown for the primary incisors over others.[9,10] RSCs had previously been referred to as the most esthetic option for primary anterior teeth, until the invention of pediatric zirconia crowns.[6,7,11,12]

Although the zirconia crown has recently gained more popularity in pediatric dentistry, due to its excellent esthetics and biocompatibility, it still has some shortcomings.[6] The zirconia crown requires more tooth preparation than does the SSC.[13] It also has about a 20 percent higher estimated total cost of materials than the RSC.[7] Because its shape cannot be altered and only two shades are available,[6] the zirconia crown may not be suitable for crowded arches or single-tooth restorations. Moreover, it cannot be crimped for a tight marginal seal and must be passively fit on placement.[6] Consequently, its retention depends considerably on good hemorrhage control and proper cementation.[6,13,14] These disadvantages of the zirconia crown may discourage pediatric dentists in Thailand, and possibly in other developing countries, from its routine use.

Consequently, the RSC is still a contemporary esthetic restoration for maxillary primary incisors that need full-coverage restorations, although the RSC is highly technique-sensitive, especially in moisture control and in obtaining proper bonding during placement.[6] However, few studies have evaluated the clinical outcomes or parental and patient satisfaction with RSCs.[11,15-17]

Previous studies regarding clinical outcomes of RSCs took place in private practice settings in Israel with patients of moderate to high economic status.[11,15-17] The RSC evaluation criteria were based on the modified United States Public Health Service (**USPHS**) criteria.[18] In 2007, the Scientific Committee of the International Dental Federation (**FDI**) published criteria for the clinical evaluation of direct and indirect restorations; these criteria were updated in 2010.[19,20] The FDI criteria are recommended as "standard criteria" for clinical research on restorative materials or restorations and for dental practitioners to evaluate their own dental work in daily practice.[19] Since 2007, the use of the FDI criteria has increased significantly, because they are practical, relevant, and standardized, allowing comparisons of the outcomes between studies.[21] Based on these criteria, restorations are evaluated in regard to esthetic, functional, and biological properties. Each property has different subcategories that can be selected, depending on the primary outcomes of interest. Each subcategory or each criterion can be assessed using ordinal scores (one to five), ranging from clinically excellent to clinically poor. These scores can be pooled to simplify the scoring system. For example, scores one, two, and three can be combined to indicate "clinically acceptable," whereas "clinically unacceptable" results from combining scores four and five.[19,20]

To the best of our knowledge, clinical outcomes of RSCs in primary maxillary incisors using the FDI criteria have not been reported. The purpose of this study was, therefore, to evaluate clinical outcomes, and parental and patient satisfaction

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with resin strip crowns placed in a university setting within primary maxillary central and lateral incisors.

Methods

Study population. This cross-sectional descriptive study was approved by the Human Experimentation Committee, Faculty of Dentistry, Chiang Mai University (**CMU**), Thailand. The inclusion criteria for this study were: the presence of at least one RSC on a primary maxillary central or lateral incisor; the RSC must have been placed between January 1, 2012, and December 31, 2013, in CMU's pediatric dental clinic; the RSC must have been placed due to caries, pulp therapy, or crown fracture, when indicated[3]; and the RSC follow-up period must have been at least 12 months after placement. All RSCs had been placed under a standardized technique by dental students or postgraduate students under the close supervision of experienced clinical instructors, who were specialized in pediatric dentistry, or had been placed by those instructors.[3] Patients had been treated using behavior guidance, suited to their levels of cooperation, including basic behavior guidance, protective stabilization, sedation, and general anesthesia. The parents of patients whose teeth satisfied the inclusion criteria were requested to participate in this study. Consent forms signed by the parents and patient verbal assents were obtained before the study. The exclusion criteria were patients who could not be contacted or whose RSC-treated teeth were no longer present intraorally due to extraction, normal exfoliation, or trauma. Because this retrospective study evaluated the treatment procedures

Table 1. FDI WORLD DENTAL FEDERATION CRITERIA USED TO ASSESS ESTHETIC, FUNCTIONAL AND BIOLOGICAL PROPERTIES OF RESIN STRIP CROWNS[19,20]

FDI criterion	Clinically acceptable			Clinically unacceptable	
	1: Clinically excellent	**2: Clinically good**	**3: Clinically sufficient/ satisfactory**	**4: Clinically unsatisfactory (but reparable)**	**5: Clinically poor (replacement necessary)**
1) Esthetic 1.1) surface gloss, luster and roughness	Comparable to enamel	Slightly dull, not noticeable from speaking distance; some isolation pores	Dull surface but acceptable if covered with film of saliva; multiple pores on ≥⅓ of the surface	Rough surface, cannot be masked by saliva film, simple polishing is not sufficient; voids	Quite rough, unacceptable plaque retentive surface
1.2) Surface and marginal staining	No staining	Minor staining, easily removable	Moderate staining that may also present on other teeth, not esthetically unacceptable	Unacceptable pronounced staining; major intervention necessary for improvement	Severe staining; not accessible for intervention
1.3) Color match and translucency	Good color match, no difference in shade and/or translucency	Minor deviations	Distinct deviation but acceptable; does not affect esthetics	(Localized) clinical deviation that can be corrected by repair	Unacceptable; replacement necessary
1.4) Esthetic anatomical form	Form is ideal	Form deviates only slightly from the norm	Form deviates from the norm but esthetically acceptable	Form is affected and unacceptable esthetically	Form is completely unsatisfactory and/ or lost
2) Function 2.1) Fracture and retention	Restoration retained, no fractures, cracks, or chipping	Small hairline crack	Two or more or larger hair-line cracks and/or chipping (not affecting the marginal integrity or proximal contact)	Material chip fractures which damage marginal quality or approximal contacts; bulk fractures with partial loss (<½ of the restoration)	(Partial or complete) loss of the restoration or multiple fractures
2.2) Marginal adaptation	Harmonious outline, no gaps, no white or discolored lines	Small marginal fracture removable by polishing; slight ditching, slight step/flashes, minor irregularities	Several small marginal fractures; major irregularities, ditching, flash or steps	Severe ditching or marginal fractures; larger irregularities or steps (repair necessary)	Restoration (complete or partial) is loose but in situ; generalized major gaps or irregularities
3) Biological 3.1) Secondary caries	No secondary or primary caries	Small and localized demineralization	Larger areas of demineralization, dentin not exposed	Caries with cavitation and suspected undermined caries	Deep secondary caries or exposed dentin that is not accessible for repair
3.2) Periodontal response	No plaque, no inflammation	Little plaque, no inflammation (gingivitis)	Plaque accumulation at acceptable level; gingival bleeding acceptable	Plaque accumulation or gingival bleeding not acceptable	Severe/acute gingivitis or periodontitis

routinely used in clinical teaching, no control or comparison groups were used.

Data collection. Patient demographic data were collected. Relevant information about RSC placement procedures were retrieved from the patients' records. Patient oral status, oral hygiene, and caries risk were evaluated by two investigators using the Silness and Loe plaque index[22] and the American Academy of Pediatric Dentistry caries risk assessment form.[23]

Evaluation of RSC clinical outcomes. All RSCs were clinically assessed using the FDI criteria by one pediatric dentist who had not been involved with the RSC placement. Each RSC was evaluated regarding three properties, with a total of nine selected subcategories, using five scores, as outlined in Table 1. Conventional periapical radiographs of the RSCs were recorded and evaluated by the same examiner. The radiographic assessment was defined as "acceptable" if there was a harmonious transition between restoration and tooth and no pathosis. However, if there were gaps between the tooth-restoration interfaces, over-hanging margins, secondary caries, apical pathosis, or tooth or restoration fracture, the result was recorded as "unacceptable." The overall score for each property was dictated by the worst score among the subcategories. The overall clinical outcome score was determined by the worst score among the three properties.[19,20]

Calibration. The examiner was trained and calibrated using the web-based training and calibration tool at www.e-calib.info.[24] A set of clinical photographs and radiographs of RSCs, which were not subjects of this study, was used for initial calibration and re-evaluation, seven days apart. The intraexaminer reliability assessed by kappa coefficient was over 0.80 for all of the clinical and radiographic assessments.

Evaluation of parental satisfaction. Each parent was interviewed by either of the two investigators, who also had not been involved with the RSC placement. They were interviewed about their perception of the RSC regarding esthetics, pain, discomfort, chewing function, ease of cleaning, gingival bleeding and gingival health surrounding the RSC, and other problems related to the RSC, such as irritation of the tongue. The parents were informed that situations during the treatment procedure should not be taken into consideration in reporting their satisfaction with the RSC. Parental satisfaction with each RSC concerning its esthetic, functional, and biological properties, including their overall satisfaction with the RSC, were graded according to three scores: (1) satisfactory; (2) unsatisfactory/repair needed; and (3) unsatisfactory/replacement needed. Moreover, parents were asked whether or not they would agree to an RSC again if a primary maxillary incisor needed a full-coverage crown.

Table 2. PARTICIPANT AND SAMPLE CHARACTERISTICS

Participants (N=41)	
Age, average (years) *Mean±(SD)* (95% *confidence interval* [CI])	
At resin strip crown placement	4.4±1.2 (2.2-6.7)
At resin strip crown follow-up	6.2±1.2 (3.8-8.6)
Gender N (%)	
Male	26 (63.4)
Female	15 (36.6)
Oral status	
High caries risk: N (%)	41 (100)
Pretreatment decayed, missing, and filled permanent teeth score: Mean±(SD) (95% CI)	12.0±5.0 (1.0-19.0)
Plaque index, average: Mean±(SD) (95% CI)	1.8±0.5 (1.0-2.7)
Parents N (%)	
Mother	27 (65.8)
Father	10 (24.4)
Other relatives	4 (9.8)
Types of anesthesia N (%)	
Local anesthesia	31 (82.9)
Oral sedation	4 (7.3)
General anesthesia	3 (9.8)
Patient's behavior during treatment N (%)	
Frankl behavioral score as "Definitely positive"	17 (41.5)
Frankl behavioral score as "Positive"	6 (14.6)
Frankl behavioral score as "Negative"	12 (29.3)
Frankl behavioral score as "Definitely negative"	1 (2.4)
Not recorded by the operators	5 (12.2)
Use of physical restraint during treatment	8 (19.5)

Table 2. CONTINUATION

Samples (teeth with resin strip crowns) (N=72)	
Follow-up period, average (months) *Mean±(SD)* (95% CI)	
At resin strip crown follow-up	21.7±6.3 (12.0-32.7)
Follow-up period (months) N (%)	
12-18	23 (31.9)
19-24	29 (40.3)
25-33	20 (27.8)
Tooth N (%)	
Central incisors	43 (59.7)
Lateral incisors	29 (40.3)
Pretreatment diagnosis N (%)	
Dental caries	59 (81.9)
Pulpal diseases	9 (12.5)
Crown fracture	4 (5.6)
No. of tooth surfaces affected by caries or trauma	
1	17 (23.6)
2	38 (52.8)
3	12 (16.7)
≥4	5 (6.9)
Pulp therapy N (%)	
None	52 (72.2)
Liner, base* and indirect pulp treatment	4 (5.6)
Pulpotomy †	1 (1.4)
Pulpectomy with Vitapex™	15 (20.8)
Operators N (%)	
Dental students	61 (84.7)
Postgraduate students	10 (13.9)
Clinical instructor in pediatric dentistry	1 (1.4)

* Liner, base used was resin-modified glass ionomer cement (Vitrobond; 3M ESPE, St. Paul, Minn., USA).

† Medicament for pulpotomy was 2.5% sodium hypochlorite.

Evaluation of patient satisfaction. Overall patient satisfaction was assessed by interviewing the patient to select the face that best matched his or her satisfaction with the RSC in their mouth from a modified Andrew and Withey satisfaction faces scale.[25] The three-face scale represented satisfied, neutral, and unsatisfied.

Statistical analysis. Data were collected and analyzed using SPSS 17.0 software (SPSS Science, Chicago, Ill., USA). The outcomes were reported by percentage and frequency. The outcomes were assessed among three follow-up periods (12 to 18, 19 to 24, and 25 to 33 months).

Results

A total of 131 RSCs in 64 patients were placed. Twenty-three patients were lost to follow up due to: our inability to contact them (N equals four); their refusal to participate (N equals 15); the fact that their RSC follow-up period was less than 12 months (N equals one); or the fact that their RSCs were lost due to extraction, exfoliation, or trauma (N equals three). Consequently, a total of 72 RSCs in 41 patients were evaluated. Table 2 shows the characteristics of the participants and teeth (RSCs).

RSC clinical outcomes. Table 3 shows the clinical outcomes of RSCs evaluated as "clinically acceptable." Most RSCs were acceptable esthetically (79.2 percent with acceptable surface luster, staining, color stability and translucency, and anatomic form) and biologically (84.7 percent with acceptable secondary caries, periodontal response, and radiographic examination). However, less than half (47.2 percent) of the RSCs were acceptable functionally, whereas 52.8 percent of the RSCs demonstrated either fracture, retention problems, or unacceptable marginal adaptation. Overall clinical outcomes of RSCs were mostly "clinically unacceptable" (56.9 percent), with the largest proportion of them (43.0 percent) scored as "clinically unsatisfactory but reparable"; additionally, 10 RSCs (13.9 percent) scored as "clinically poor, replacement necessary."

Parental and patient satisfaction. Contrary to the professional evaluation, parents scored most RSCs as "clinically satisfactory" in functional (84.7 percent) and biological properties (93.1 percent), but only 55.6 percent of RSCs were scored as "clinically satisfactory" in esthetics. Among the 32 RSCs that were scored as "clinically unsatisfactory" esthetically by the parents, the dentist scored nine RSCs as "clinically unacceptable" esthetically, 17 RSCs as "clinically unacceptable" functionally, and 13 RSCs as "clinically acceptable" in all properties.

For patient satisfaction, six patients (14.6 percent) rated their overall satisfaction with RSCs as "neutral." Most of these patients had RSCs, which were rated as "clinically unacceptable" by the dentist (five patients) or "clinically unsatisfactory" by their parents (four patients). Four patients (9.8 percent) rated the RSCs as "unsatisfied." Among them, two patients had complete loss of RSCs, one patient had a poorly color-matched RSC, and another patient had a "clinically acceptable" RSC, when evaluated by the dentist.

Overall satisfaction of the parents and patients was high (90.2 percent and 75.6 percent, respectively). Moreover, most parents (95.1 percent) would choose an RSC again if their child needed an anterior crown (Table 3).

Esthetic properties. Among the 57 RSCs (79.2 percent) that were scored as esthetically "clinically acceptable", all of them were scored as "clinically sufficient" (55.6 percent) or "clinically good" (23.6 percent), while none were rated as "clinically excellent." Seven RSCs (9.7 percent) were scored as "clinically poor, replacement necessary," due to complete loss of the RSCs; these RSCs were rated as "clinically poor" functionally and biologically as well as esthetically. Eight RSCs (11.1 percent) were scored as esthetically "clinically unsatisfactory but reparable". Among these teeth, five RSCs had unacceptable color match and translucency; four of them (80 percent) had received a pulpectomy treatment (Figure 1). However, among the 15 pulpectomized teeth in this study, most (66.7 percent) were scored as esthetically "clinically sufficient" (66.7 percent).

Functional properties. Thirty-eight RSCs (52.8 percent) were scored as functionally "clinically unacceptable". Most were clinically unacceptable in two subcategories: marginal adaptation (44.4 percent); and fracture and retention (40.6 percent). In these two subcategories, most RSCs were scored as "clinically unsatisfactory but reparable" in marginal adaptation (34.7 percent) and in fracture and retention (20.8 percent). Among the 32 RSCs that had "clinically unacceptable" scores in marginal adaptation, 14 of them had "clinically unacceptable" scores in radiographic assessment, because of the presence of gaps in the tooth-restoration interfaces. Additionally, those scored as "clinically poor, replacement necessary" in overall function (13.9 percent) were the seven teeth with complete loss of RSCs combined

Table 3. PERCENTAGES AND FREQUENCIES OF RESIN STRIP CROWN CLINICAL OUTCOMES AND PARENTAL AND PATIENT SATISFACTION SCORED AS "CLINICALLY ACCEPTABLE" AND "CLINICALLY SATISFACTORY," ACCORDING TO EACH EVALUATION CRITERION

Evaluation criterion	Clinically acceptable by dentist N (%)	Clinically satisfied by parents N (%)	Clinically satisfied by patients N (%)
Esthetic properties (N=72)			
Surface gloss, luster and roughness	64 (88.9)	NA*	NA
Surface and marginal staining	63 (87.5)	NA	NA
Color match and translucency	60 (83.3)	NA	NA
Esthetic anatomical form	64 (88.9)	NA	NA
Overall esthetic evaluation	**57 (79.2)**	**40 (55.6)**	NA
Functional properties (N=72)			
Fracture and retention	50 (59.4)	NA	NA
Marginal adaptation	40 (55.6)	NA	NA
Radiographic assessment	53 (73.6)	NA	NA
Overall functional evaluation	**34 (47.2)**	**61 (84.7)**	**NA**
Biological properties (N=72)			
Secondary caries	63 (87.5)	NA	NA
Periodontal response	69 (95.8)	NA	NA
Overall biological evaluation	**61 (84.7)**	**67 (93.1)**	NA
Overall			
Overall clinical outcomes (N=72)	**31 (43.1)**	**NA**	**NA**
Overall satisfaction (N=41)	**NA**	**37 (90.2)**	**31 (75.6)**

* NA = not assessed.

with three other teeth with partial loss of RSCs. All cases with complete loss of RSCs had follow-up periods of over 20 months. None of the RSC-treated teeth had apical pathosis.

Biological properties. The majority of RSCs that were biologically "clinically unacceptable" were in the subcategory of secondary caries (nine out of 72; 12.5 percent). Seven out of nine teeth were the same teeth that had complete loss of RSCs, whereas the other two teeth had partial loss of RSCs with dentin exposure. Only three RSCs (4.2 percent) had unacceptable periodontal responses. All of them were scored as "clinically unsatisfactory but reparable."

Table 4. PERCENTAGES AND FREQUENCIES OF RESIN STRIP CROWN CLINICAL OUTCOMES SCORED AS "CLINICALLY ACCEPTABLE" AMONG DIFFERENT FOLLOW-UP PERIODS

Follow-up period (months)	Clinically acceptable outcome according to each evaluation criterion: N (%)			
	Esthetic	Functional	Biological	Overall
12-18 (N=23)	20 (87.0)	15 (65.2)	22 (95.7)	14 (60.9)
19-24 (N=29)	23 (79.3)	12 (41.4)	23 (79.3)	12 (41.4)
25-33 (N=20)	14 (70.0)	7 (35.0)	16 (80.0)	5 (25.0)

Figure 1. Example of a resin strip crown on the primary maxillary right central incisor scored as "clinically unsatisfactory but reparable" esthetically in the color match and translucency subcategory of the FDI World Dental Federation criteria. This tooth was treated with pulpectomy using Vitapex™.

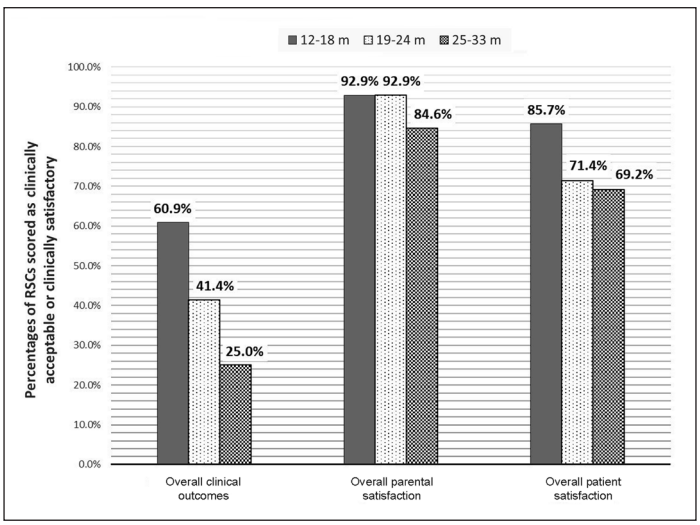

Figure 2. Bar graph showing percentages of resin strip crowns' (RSCs) overall clinical outcomes scored as "clinically acceptable" and of parental and patient satisfaction with RSCs scored as "clinically satisfactory" among the three follow-up periods. For the overall clinical outcomes, the number of RSCs in the 12- to 18-, 19- to 24-, and 25- to 33-month follow-up periods were 23, 29, and 20, respectively. For the overall parental and patient satisfaction, the number of subjects (parents or patients) in the 12- to 18-, 19- to 24-, and 25- to 33-month follow-up periods were 14, 14, and 13, respectively.

Comparison between the three follow-up periods. Table 4 shows the distribution of "clinically acceptable" RSCs in the three criteria among the three follow-up periods. The percentages of esthetically and biologically "clinically acceptable" RSCs were slightly higher in the shorter follow-up periods. However, the percentages of "clinically acceptable" RSCs in function and in overall clinical outcomes were evidently lower in the longer follow-up periods. Figure 2 presents the overall clinical outcomes of RSCs evaluated by the dentist, using the FDI criteria, and the overall satisfaction of the parents and patients among the follow-up periods. These outcomes were highest in the 12- to 18-month follow-up period and lowest in the 25- to 33-month follow-up period.

Discussion

Our study was designed to assess the RSC from professional, parental, and patient viewpoints. According to the FDI criteria, the overall clinical outcomes should be dictated by the worst score among the three evaluated properties. Most of the RSCs in our study were "clinically acceptable" in esthetics and biologically, as evaluated by the dentist evaluator. However, our study had a significant number (56.9 percent) of "clinically unacceptable" RSCs in overall outcomes, as most of them were "clinically unacceptable" functionally. Overall satisfaction of parents and patients was obtained from their interview answers rather than from the worst score among the criteria, resulting in high satisfaction with the RSCs, although the parents were less satisfied with the RSCs in esthetics than in the other properties. This low parental satisfaction in esthetics and high percentage of esthetically acceptable RSCs, when evaluated by the dentist evaluator, indicate that the parental viewpoint in esthetics or in the success of the restoration may have been different from the clinical assessments of dentists, as suggested by Kupietzky and Waggonner.[16] Moreover, the parents did not consider their overall satisfaction from a single unsatisfactory criterion but rather from many dimensions of treatment.[9,16]

The values placed on primary teeth may also influence the opinion of parents from different cultures.[26] We speculate that, as with the Chinese parents in the study of Wong et al.,[27] the Thai parents in our study had a common cultural belief that primary teeth eventually exfoliate, resulting in their ascribing a low value to primary teeth. During data collection, it was common to find a parent explain that "I am satisfied with the RSC, as long as my child does not have a toothache or discomfort," or "although the RSC's appearance does not meet my expectation, the tooth looks much nicer than it did previously." However, esthetics may be the top priority of young patients in their satisfaction with RSCs.[28] In our study, a majority of the patients (three out of four) who were dissatisfied with their RSCs had RSCs with an unappealing appearance. A recent study reported that young children had negative self-perception when their teeth had altered esthetic conditions.[29] Moreover, children have been reported to have low self-esteem when they have had extensive carious primary incisors.[30] This esthetic self-consciousness of children may have been the cause of the lower satisfaction of the patients than that of the parents in our study.

By contrast, children have been reported to be less critical than their parents of the appearance of incisors with mild caries but have similar opinions to their parents regarding deep anterior caries.[28] In our study, most children who reported their overall satisfaction with RSCs as "neutral" had "clinically unacceptable" or "unsatisfactory" RSCs when evaluated by the dentist or parents. This suggests that young patients tend to have various opinions regarding their teeth and their need for restorations. Consequently, clinicians should determine the qualities of a restoration that the parent and patient value most. The choice of restoration, including the procedure, clinical outcomes, and cost of the treatment, should be discussed with them when planning to restore primary incisors. Through this decision-making process, the restoration that best matches parent and patient expectation should be chosen.[16]

The "clinically acceptable" score of the FDI criteria in our study was equal to the alpha score combined with the beta score of the modified USPHS criteria used in a previous study with a comparable average follow-up period.[11] Esthetically, the percentages of clinically acceptable RSCs in the subcategory of color match and anatomical form (or crown contour) were high in both studies, with slightly lower percentages in our study (83.3 percent versus 95 percent for color match, and 88.9 percent versus 97 percent for anatomical form, respectively). Biologically, the percentages of clinically acceptable RSCs in the sub-category of periodontal responses (or gingival health above restorations) were very high in both studies (93.8 percent versus 100 percent, respectively). However, functionally, the percentages of clinically acceptable RSCs in the subcategory of fracture and retention were much lower in our study (59.4 percent versus 98 percent, respectively). However, the retention rate in our study was close to that in a previous study by Tate et al. (49 percent versus 59.4 percent, respectively).[31]

The lower percentage of clinically acceptable RSCs in our study in all aforementioned subcategories compared to others may have been due to differences in evaluation criteria or methods used for the RSC evaluation. In our study, the FDI criteria were used because of the high sensitivity and standardization of the criteria, which allow fair comparison of the clinical outcomes with those of other studies.[19-21] Moreover, direct clinical evaluation intraorally, as performed in our study, may have had greater sensitivity and validity than either the two-dimensional photographic or radiographic evaluation, or, retrospective review of charts, as in previous studies.[11,15,17] Based on our experience, most clinically unacceptable RSCs in function had flaws in the marginal adaptation on the palatal surface (Figure 3); such flaws may not be easily assessable via photographic assessment. Moreover, the difference in clinical settings among the studies may have been the cause of the difference in success rates.

Figure 3. Example of resin strip crowns on four primary maxillary incisors scored as "clinically poor, replacement necessary" functionally in the fracture and retention and marginal adaptation subcategories of the FDI World Dental Federation criteria.

This study was conducted in a university setting, which was very different from the private practice settings in the other studies.[11,15,17] Because the RSC is a very technique-sensitive anterior restoration,[6] the clinical experience of the operator may be an important factor in the success of RSCs. Bücher et al.[32] reported that composite restorations in primary teeth placed by less-skilled dentists showed lower survival probability than those placed by more experienced operators. The fact that most of the RSCs in our study were placed by post-graduate students and some as their very first experience may have contributed to the large number of "clinically unacceptable" RSCs in our study. Other factors that may have contributed to the lower success of RSCs in this study may be that the RSCs were placed by many operators, the behavior of the patients, parental engagement in their children's oral care, and the follow-up periods.

Although the RSC was once quoted as the most esthetic option for primary incisors,[3] the results of our study do not support this idea. Although the majority of RSCs in this study were rated as "clinically acceptable" esthetically, none of them were rated as "clinically excellent" esthetically. In a previous study, no difference was found in the appearance, color, size, or durability of RSCs between parental satisfaction and professional evaluation.[16] However, in our study, discrepancies were found between parental and professional evaluations of RSCs in esthetics and function. Esthetically, only 55.6 percent of the RSCs were rated as "clinically satisfactory" by the parents, whereas 79.2 percent of the RSCs were rated as "clinically acceptable" by the dentist. This signified that esthetics is the most essential quality of RSCs required by the parents in modern pediatric dental practice.[33-35] Consequently, it is mandatory to inform parents about the limitations of RSCs in esthetics, especially in some conditions—for example, possible color and translucency mismatches in pulpectomized teeth[11,15] or possible loss of crown material in long-term RSCs (i.e., more than 20 months). A study investigating children's and parents' esthetic acceptance of different treatment modalities (no treatment, open-faced SSC, RSC, and zirconia crown) for extensive carious primary incisors reported that zirconia crowns are the anterior crowns most esthetically acceptable to both patients and parents.[28] Consequently, if parents expect an excellent esthetic restoration with durable performance, the zirconia crown should be the restoration of choice.[7,9,35] Nevertheless, if a zirconia crown is not suitable, the esthetics of an RSC may be improved by carefully selecting the shade, opacity, and translucency of the composite material using a multiple-layering technique and meticulous technical skills during treatment and arranging frequent recall and maintenance.[11,36]

In our study, the clinical acceptability of RSCs in esthetic, functional, and biological properties, including the overall parental and patient satisfaction, tended to gradually decrease (Table 4 and Figure 2). These results differ from previous studies[15,16] by one group of authors from the same private practice who evaluated the clinical success of RSCs after three years[15] and parental satisfaction with RSCs after an average of 17.8 months.[16] In one of those studies,[15] the retention of RSCs were slightly lower for RSCs present for over three years

(73 percent) than for those present for less than two years (83 percent). In the other study,[16] parental satisfaction with RSCs in color and size, including their overall satisfaction, was similar among various follow-up periods (less than six, seven to 12, 13 to 24, and over 25 months). We propose that dental practitioners and parents should be aware of the limitations of RSCs but should not be discouraged from using them in restoring primary maxillary incisors, because other studies from private practice settings have shown high success rates (approximately 80 percent) at longer follow-up periods.[15,17]

Although few studies regarding long-term clinical outcomes of the more durable anterior crowns, such as preveneered crowns or zirconia crowns, are available,[6] Holsinger et al.[7] reported that zirconia crowns had a high retention rate (96 percent) and a high level of parental satisfaction, with an average crown age of 20.8 months. Consequently, it may be more prudent to consider using zirconia crowns if they are available in the practice, and are affordable by the parents. Considering that the ultimate goal of restoring primary maxillary incisors is to maintain teeth in a healthy state until normal exfoliation,[11,15] the decision to repair or replace RSCs should be debated, with consideration of the time to normal exfoliation. If a tooth with a clinically unacceptable RSC is expected to exfoliate within a short period of time and has no active caries or pulpal symptoms, monitoring the tooth under active surveillance may be a legitimate, conservative approach.

A limitation of this retrospective cross-sectional study was that the availability of data relevant to the clinical outcomes of RSCs was not complete. Many factors may contribute to the unsatisfactory marginal adaptation and retention of RSCs. These include the preoperative tooth conditions, patient factors (e.g., habits, occlusion, spacing, or crowding of maxillary anterior teeth), complications during treatment (e.g., gingival bleeding, moisture control difficulty), amount of enamel available for bonding, adhesive systems, and composite resin used.[32,35] However, this study's design was not ideal for analyzing correlations between these possible associated factors and the clinical outcomes of RSCs. Nevertheless, this study highlighted the fact that the RSC has limitations in its esthetic and functional properties; therefore, RSC is not the best restoration for primary incisors when there are high esthetic and durability expectations. The clinical outcomes of RSCs described in this study in a university setting may not be close to those achieved in other clinical settings.[15,17] Moreover, the clinical outcomes of the excluded teeth and the opinions of the excluded participants may be different from those included in this study. To avoid information bias, we did not collect data from those whose teeth were extracted or had inadequate follow-up periods. For further study, prospective design should be considered. Consequently, well-designed, prospective clinical studies or randomized, controlled trials comparing different RSC placement techniques and different materials, or comparing RSCs to other restorative options, would be useful.

Conclusions

Based on the results of this study from a university setting, the following conclusions can be made:

1. When judged by a dentist, resin strip crowns were clinically acceptable esthetically and biologically for restoring primary maxillary incisors. However, RSCs had major disadvantages in function, especially in marginal adaptation or fracture and retention. Moreover, these drawbacks increased with increased follow-up time.
2. By contrast, parents had the highest satisfaction with the functional and biological properties of RSCs but the lowest in the esthetic property. However, the parental and patient overall satisfaction with RSCs was high and remained fairly high during the follow-up periods.

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References

1. Webber DL, Epstein NB, Wong JW, Tsamtsouris A. A method of restoring primary anterior teeth with the aid of a celluloid crown form and composite resins. Pediatr Dent 1979;1(4):244-6.
2. Croll TP. Bonded composite resin crowns for primary incisors: technique update. Quintessence Int 1990;21(2):153-7.
3. Kupietzky A. Bonded resin composite strip crowns for primary incisors: clinical tips for a successful outcome. Pediatr Dent 2002;24(2):145-8.
4. Castro A, Badr SB, El-Badrawy W, Kulkarni G. Clinical performance of pedo jacket crowns in maxillary anterior primary teeth. J Dent Child (Chic) 2016;83(3):125-31.
5. Waggoner WF. Anterior crowns for primary anterior teeth: an evidence-based assessment of the literature. Eur Arch Paediatr Dent 2006;7(2):53-7; discussion 57.
6. Waggoner WF. Restoring primary anterior teeth: updated for 2014. Pediatr Dent 2015;37(2):163-70.
7. Holsinger DM, Wells MH, Scarbecz M, Donaldson M. Clinical evaluation and parental satisfaction with pediatric zirconia anterior crowns. Pediatr Dent 2016;38(3):192-7.
8. Venkataraghavan K, Chan J, Karthik S. Polycarbonate crowns for primary teeth revisited: restorative options, technique and case reports. J Indian Soc Pedod Prev Dent 2014;32(2):156-9.
9. Salami A, Walia T, Bashiri R. Comparison of parental satisfaction with three tooth-colored full-coronal restorations in primary maxillary incisors. J Clin Pediatr Dent 2015;39(5):423-8.
10. Aiem E, Smail-Faugeron V, Muller-Bolla M. Aesthetic preformed paediatric crowns: systematic review. Int J Paediatr Dent 2017;27(4):273-82.
11. Kupietzky A, Waggoner WF, Galea J. The clinical and radiographic success of bonded resin composite strip crowns for primary incisors. Pediatr Dent 2003;25(6):577-81.
12. Waggoner WF. Restoring primary anterior teeth. Pediatr Dent 2002;24(5):511-6.
13. Clark L, Wells MH, Harris EF, Lou J. Comparison of amount of primary tooth reduction required for anterior and posterior zirconia and stainless steel crowns. Pediatr Dent 2016;38(1):42-6.

14. Stepp P, Morrow BR, Wells M, Tipton DA, Garcia-Godoy F. microleakage of cements in prefabricated zirconia crowns. Pediatr Dent 2018;40(2):136-9.
15. Kupietzky A, Waggoner WE, Galea J. Long-term photographic and radiographic assessment of bonded resin composite strip crowns for primary incisors: results after three years. Pediatr Dent 2005;27(3):221-5.
16. Kupietzky A, Waggoner WF. Parental satisfaction with bonded resin composite strip crowns for primary incisors. Pediatr Dent 2004;26(4):337-40.
17. Ram D, Fuks AB. Clinical performance of resin-bonded composite strip crowns in primary incisors: a retrospective study. Int J Paediatr Dent 2006;16(1):49-54.
18. Cvar JF, Ryge G. Reprint of criteria for the clinical evaluation of dental restorative materials. Clin Oral Investig 2005;9(4):215-32.
19. Hickel R, Peschke A, Tyas M, et al. FDI World Dental Federation: clinical criteria for the evaluation of direct and indirect restorations-update and clinical examples. Clin Oral Investig 2010;14(4):349-66.
20. Hickel R, Roulet JF, Bayne S, et al. Recommendations for conducting controlled clinical studies of dental restorative materials. Science Committee Project 2/98—FDI World Dental Federation study design (Part I) and criteria for evaluation (Part II) of direct and indirect restorations including onlays and partial crowns. J Adhes Dent 2007;9 (suppl 1):121-47.
21. Marquillier T, Domejean S, Le Clerc J, et al. The use of FDI criteria in clinical trials on direct dental restorations: a scoping review. J Dent 2018;68:1-9.
22. Loe H. The gingival index, the plaque index and the retention index systems. J Periodontol 1967;38(6):(suppl): 610-6.
23. American Academy of Pediatric Dentistry. Guideline on caries-risk assessment and management for infants, children, and adolescents. Pediatr Dent 2013;35(5):e157-e164.
24. Hickel R, Roulet JF, Heintze S, Peschke A. E-calib. Available at: "http://zep01793.dent.med.uni-muenchen.de/moodle/". Accessed September 1, 2014. (Archived by WebCite® at: "http://www.webcitation.org/6zx92TgMs")
25. Andrews FM, Withey SB. Social Indicators of Well-Being: Americans' Perceptions of Life Quality. New York, N.Y., USA: Plenum; 1976:376.
26. Ng MW. Multicultural influences on child-rearing practices: implications for today's pediatric dentist. Pediatr Dent 2003;25(1):19-22.
27. Wong D, Perez-Spiess S, Julliard K. Attitudes of Chinese parents toward the oral health of their children with caries: a qualitative study. Pediatr Dent 2005;27(6):505-12.
28. Pani SC, Saffan AA, AlHobail S, et al. Esthetic concerns and acceptability of treatment modalities in primary teeth: a comparison between children and their parents. Int J Dent 2016;2016:3163904.
29. Soares FC, Cardoso M, Bolan M. Altered esthetics in primary central incisors: the child's perception. Pediatr Dent 2015;37(5):29-34.
30. Kapur A, Chawla HS, Goyal A, Gaube K. An esthetic point of view in very young children. J Clin Pediatr Dent 2005;30(2):99-103.
31. Tate AR, Ng MW, Needleman HL, Acs G. Failure rates of restorative procedures following dental rehabilitation under general anesthesia. Pediatr Dent 2002;24(1):69-71.
32. Bücher K, Metz I, Pitchika V, Hickel R, Kühnisch J. Survival characteristics of composite restorations in primary teeth. Clin Oral Investig 2015;19(7):1653-62.
33. Woo D, Sheller B, Williams B, Mancl L, Grembowski D. Dentists' and parents' perceptions of health, esthetics, and treatment of maxillary primary incisors. Pediatr Dent 2005;27(1):19-23.
34. Holan G, Rahme MA, Ram D. Parents' attitude toward their children's appearance in the case of esthetic defects of the anterior primary teeth. J Clin Pediatr Dent 2009; 34(2):141-5.
35. Walia T, Salami AA, Bashiri R, Hamoodi OM, Rashid F. A randomised controlled trial of three aesthetic full-coronal restorations in primary maxillary teeth. Eur J Paediatr Dent 2014;15(2):113-8.
36. Mackenzie L, Parmar D, Shortall AC, Burke FJ. Direct anterior composites: a practical guide. Dent Update 2013; 40(4):297-9, 301-2, 305-8.