

Clinical Evaluation of Contemporary Ion Releasing Restorative Materials in Primary Molars Subjected to Selective Caries Removal: a randomised clinical trial



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Abstract

Aim This randomised controlled trial compared the clinical effectiveness of four ion-releasing restorative materials in the proximal cavities of primary molars that underwent selective caries removal.

Study Design This trial enrolled 86 children (262 teeth), between 5 and 9 years old (7.15 ± 1.14). The clinical performance of restorative materials (1: Equia Forte HT; 2: Fuji II LC; 3: Cention N; 4: ChemFil Rock), applied to the proximal cavities of primary molars following selective caries removal, were evaluated according to the modified USPHS criteria.

Results Pulpal perforation was observed in 12 (4.58%) teeth. Six of the restored 250 teeth showed pulpal infection symptoms. A statistically significant difference was only observed between Fuji II LC and Cention N at the 3rd month, based on retention at each time interval ($p=0.024$). When the total retention losses at the end of the study were compared, Fuji II LC was the most successful ($p<0.05$). None of the restorations received a Charlie score for marginal discoloration, marginal adaptation, color stability, and anatomic form. Secondary caries and postoperative sensitivity were absent.

Conclusion Although the superiority of materials over each other could not be proven in this study, Fuji II LC appears to be more successful in terms of retention.

KEYWORDS Cention N, ChemFil, Equia, Fuji II LC, Primary Molar Teeth.

Introduction

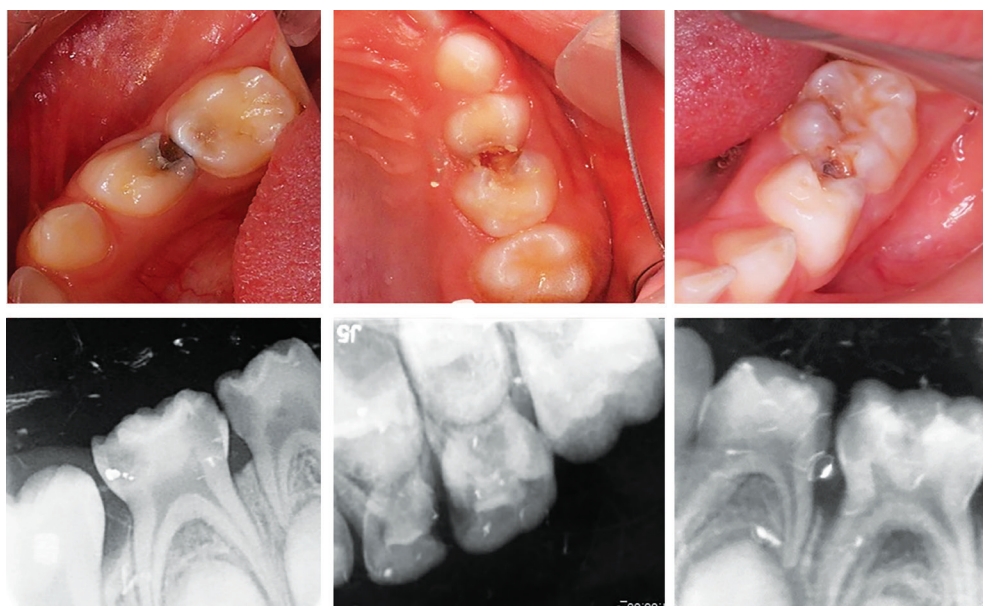
Conservative preparations are necessary and crucial for managing deep proximal cavities in primary teeth to prevent pulpal exposure and avoid prolonging treatment duration [Schwendicke et al., 2016; Arora et al., 2022]. Studies showed that selective caries removal may result in lower incidence of pulpal exposure and success regarding the preservation of pulpal vitality [Li et al., 2018]. The choice of restorative material is equally crucial in addressing deep proximal carious lesions in primary teeth. Particularly in cases involving selective caries removal, the use of a material that can adhere to the remaining dentin tissue and induce remineralisation is important [Bjorndal et al., 2010; Schwendicke et al., 2016].

Resin materials are widely used in today's dentistry [Siokis et

al., 2021]. However, in modern dentistry, the demand for simplified, aesthetic, and satisfactory tooth decay restoration has driven the development of innovative materials. Despite the clinical success of composite resins, their application requires technical precision, and they are not time-efficient when working with paediatric patients [Dias et al., 2018]. Glass-ionomer cements (GICs) on the other hand, can be applied in one step and the application does not require as much technical precision [Siokis et al., 2021]. However, GICs also have limitations, such as low fracture resistance and wear resistance. Nowadays enhanced GICs have been reported to show similar clinical success to composite resins when used in the proximal cavities of primary teeth [Dias et al., 2018; Siokis et al., 2021] and there are even studies that show GICs demonstrate higher performance in preventing secondary caries compared to resin restorative materials [Raggio et al., 2016; Dias et al., 2018]. Consequently, new formulations of GICs and other bioactive materials are still being investigated to harness the favorable characteristics of GICs [Gok Baba et al. 2021; Arora et al., 2022; da Cunha et al., 2022; Derchi et al., 2022]. These newly developed restorative materials release caries-protective ions, especially alkaline and alkaline earth ions such as calcium, in addition to phosphate or fluoride. Cention N, a newly developed bioactive material, is reported to be a promising resin-based alternative to enhanced GICs for high caries risk patients due to its high calcium release/recharge and acceptable fluoride release [Ruengrungsom et al., 2020]. Therefore, this study aims to evaluate the clinical performance of four different materials with the ability to be applied quickly and a high fluoride release feature (Equia Forte HT as a hybrid glass ionomer cement (GIC), ChemFil Rock as a zinc-reinforced high-viscosity-GIC, Fuji II LC as a resin-modified-GIC, and Cention N as a bioactive glass-containing alkaSite) in primary molar teeth where proximal carious lesions have been selectively removed.

Methods

The methodology followed the guidelines for clinical trials

**FIG. 1**

Examples of clinical and radiographic views of the first and second primary molar teeth included in the study.

recommended by the Standard CONSORT (Consolidated Standards of Reporting Trials). IRB approval was provided by the Ethical Committee for Clinical Research of Akdeniz University (09.11.2020/ E.252849) and the trial was registered to the Department of Clinical Research of the Turkish Medicines and Medical Devices Board (reg.number: 68869993-511.06).

Study Design

This single-center study is designed as a non-blinded, randomised controlled trial. Because of the limited availability of studies with similar characteristics, the sample size analysis of the study was conducted based on the reported success rates of 83% for high-viscosity-GIC [Kupietzky et al., 2019] and for resin-modified-GIC [Sengul and Gurbuz, 2015]. G*Power 3.1 software was utilised for the analysis, with 85% power and 0.5 effect size selected. The analysis revealed that a minimum of 49 restorations were required in each group. Considering the possibility of patient dropout during the 12-month study period, the sample size was increased by 20%, resulting in a decision to aim for a minimum of 60 restorations in each group. Verbal and written informed consent were obtained from the participants before the study. A total of 86 children, 42 girls and 44 boys, aged between 5 and 9 years, without any systemic disease, who sought treatment at the Department of Pediatric Dentistry at Akdeniz University Faculty of Dentistry due to dental caries in primary teeth during the years 2020–2021, were selected for this study.

Eligibility Criteria

Participants who met the following criteria: (i) absence of any systemic disease; (ii) age between 5 and 9 years; (iii) no known or suspected history of allergy to medications or restorative materials; (iv) no teeth grinding or clenching habits; (v) presence of at least one interproximal carious lesion; and teeth that met the following criteria: (vi) a deep carious lesion reaching 1/2 dentin; (vii) in contact with adjacent teeth and in occlusion with antagonist teeth; (viii) no pathological mobility; (ix) periodontally healthy; (x) no clinical symptoms requiring pulpal treatment; (xi) physiological root resorption not exceeding one-third of the root length; (xii) showed no radiolucency in the furcation areas; (xiii) had a permanent tooth germ present below the tooth, were included in the study. Attention was given to ensuring that the carious lesions included in the study were classified as 5 and 6, with a depth of D2 and D3, according to the ICDAS II (International Caries Detection and Assessment System II) criteria.

Patients who did not meet the inclusion criteria mentioned above and those who did not attend their follow-up appointments were excluded from the study.

Trial Procedures

All patients received oral hygiene education as part of the study protocol. Prior to treatment periapical radiographs and digital photographs were recorded (Fig. 1). Teeth were restored with four different restorative materials:

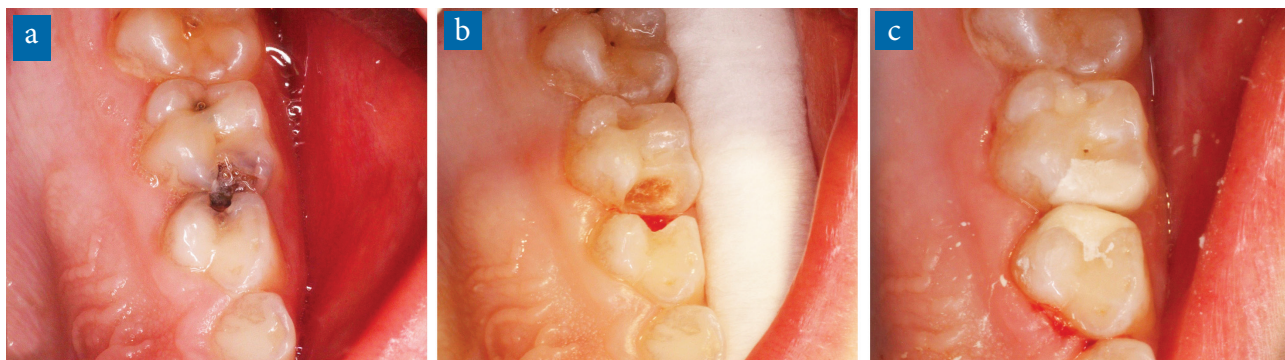
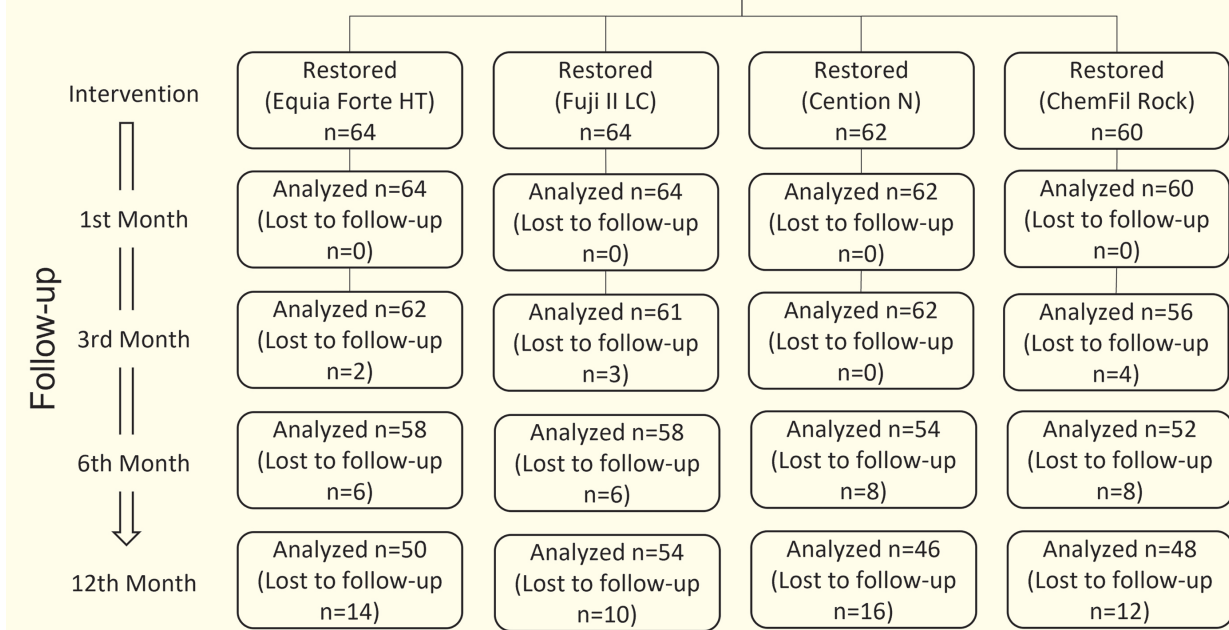


FIG. 2 Intraoral views of the primary molars restored with Fuji II LC (65) and ChemFil Rock (64): **(a)** before the preparation, **(b)** after the preparation, and **(c)** after the restoration.

FIG. 3 Trial Flowchart. Prior to the study, 376 teeth were assessed for eligibility, and 262 were found eligible. During cavity preparation, pulpal exposure was observed in 12 teeth. These teeth underwent pulpal treatments and were excluded. After the preparation was completed, restorative materials were randomly selected. During the follow-up, 16 patients (52 teeth) dropped out.



1. Hybrid GIC (Equia Forte HT, GC Corporation, Japan)
2. Resin-Modified GIC (Fuji II LC, GC Corporation, Japan)
3. Bioactive Glass-Containing Alkaline (Cention N, Ivoclar Vivadent, Liechtenstein)
4. Zinc-Reinforced High-Viscosity GIC (ChemFil Rock, Dentsply, Germany)

Restoration Procedures

The cavity preparation and restoration were performed by a single operator (ZBB). Infected dentin tissue was selectively removed using the mechanical technique with a slow-speed bur and a sharp excavator. The differentiation between infected and affected dentin was determined by the clinician through the visual-tactile method.¹⁴⁻¹⁶ Isolation was achieved with cotton rolls and suction. Sectional matrix systems (Palodent Matrix Systems, Dentsply Sirona, USA) and interdental wedges were used. In the instance of pulpal perforation, relevant teeth were treated accordingly and excluded from the clinical evaluations.

Randomisation: Randomisation was carried out after cavity preparation. The patient was asked by another researcher (AC) to select one card from four cards that had been prepared previously, each measuring 5.5 x 8.5 cm. Then the first researcher (ZBB) completed the restorations (Fig. 2). Materials were mixed according to the manufacturers' instructions.

Application of Equia Forte HT: The material in capsule form was placed in the mixer (Ultramat 2, SDI, Australia) and mixed for 10 seconds, and then applied to the cavity in a single step. The restorative material was light-cured for 20 seconds using an LED light device (VALO, Ultradent, Utah, USA). Equia Forte Coat

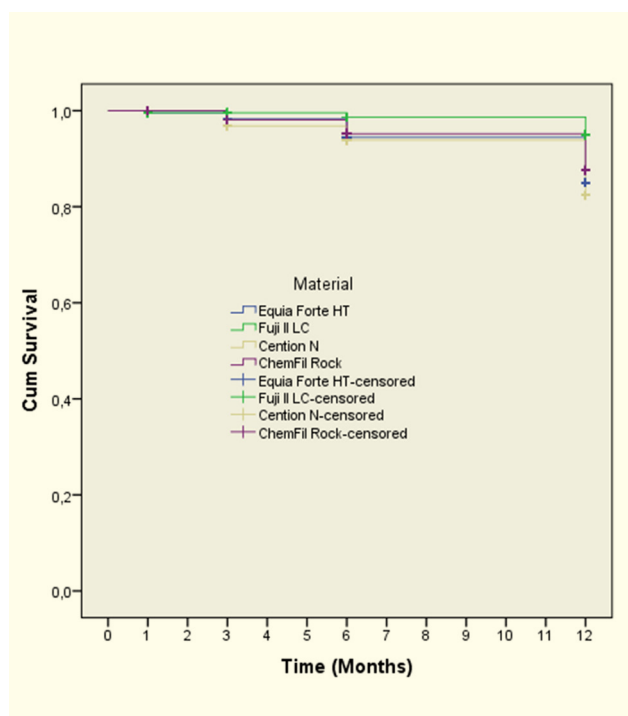


FIG. 4 Kaplan-Meier survival analyses.

was applied and light-cured for 20 seconds.

Application of Fuji II LC: The material in capsule form was mixed in the mixer (Ultramat 2, SDI, Australia) for 10 seconds, and the applied to the cavity in a single step. Light-curing was achieved using an LED light device (VALO, Ultradent, Utah, USA) for 20 seconds.

Application of Cention N: The material was mixed using a plastic spatula on a mixing pad or glass with a powder-to-liquid ratio of 1:1 until it reached a homogeneous consistency, which took approximately 45–60 seconds. Then the material was applied to the cavity and allowed to set for the self-curing time of 4 and a half minutes.

Application of ChemFil Rock: The material in capsule form was placed in the mixer (Ultramat 2, SDI, Australia) and mixed for 12 seconds, and then applied to the cavity in a single step. In addition to the 90-second working time, an additional 4 and a half minutes were allowed for the material to cure.

Evaluation of the Clinical Success

Evaluations were conducted at the 1st, 3rd, 6th, and 12th months. Restorations were evaluated for retention, marginal discoloration, marginal adaptation, color stability, recurrent caries, and postoperative sensitivity according to the modified USPHS.11, 17, 18 All clinical assessments were performed by a single operator (ZBB). In instances of retention loss, teeth were investigated for secondary caries formation using the visual-tactile method.

Statistical Analyses

The statistical analysis of the results was conducted by entering the collected data into the SPSS package program (SPSS 18.00 for Windows, Chicago, IL, USA). Descriptive statistics such as minimum, maximum, mean, standard deviation, etc., were calculated. Reliability analyses and comparative tests were also performed.

For the analysis of qualitative data obtained in our study and for comparing groups, Kruskal-Wallis, Mann-Whitney U, Wilcoxon, Fischer's exact test, and chi-square (χ^2) tests were used. The interactions between two different group variables were assessed using the Pearson correlation test. The results were evaluated at a significance level of $p < 0.05$ with a 95% confidence interval.

Results

In accordance with the established criteria, 262 primary molars were selected for the study. The mean age of the children included in the study was found to be 7.15 ± 1.14 (girls: 7.22 ± 1.09 , boys: 7.08 ± 1.18). The difference in age distribution between genders was not statistically significant ($p > 0.05$). The study was concluded after the completion of the patients' 12-month follow-up period.

Pulpal perforation was observed in 12 (4.58%) teeth. These teeth underwent pulpal treatments and were excluded from the

evaluations according to USPHS criteria. A total of 250 teeth from 84 children were restored with the study materials. During the follow-up period, six of the restored teeth showed pulpal infection symptoms, and these teeth were treated with root canal treatment and excluded from the evaluations according to USPHS criteria (Table 1).

At the 12th month, 198 restorations were followed. Retention loss was observed in 15 of the 198 teeth. Study was completed with 183 teeth in 68 patients due to the inability to follow up with 16 patients for various reasons (change of contact number, moving out of the city, not answering the phone, etc.).

The total number of teeth assigned to each group at the beginning of the study and the characteristics of the cavities are shown in Table 2. The number of teeth included in the analyses at all follow-up points is indicated in Figure 3. Patients treated with one filling comprised 4.7% of the sample, those treated with two different restorative materials comprised 32.1%, patients treated with three different restorative materials comprised 33.3%, and those treated with four different restorative materials comprised 32.1%. A total of 12 restorations in the Equia Forte HT group, 4 restorations in the Fuji II LC group, 14 restorations in the Cention N group, and 10 restorations in the ChemFil Rock group failed due to retention loss. The distribution of retention loss observed in the groups by month is summarised in Table 2 and Figure 4. When inter-group comparisons were made based on retention at each time interval, a statistically significant difference was only observed between Fuji II LC and Cention N at the 3rd month ($p = 0.024$) (Table 3).

However, when the total retention losses at the end of the study were compared, Fuji II LC was the most successful ($p < 0.05$). When the intra-group comparisons were made based on the months, it was observed that all the materials showed significant differences at certain time intervals except for Fuji II LC (Table 3). When retention losses were evaluated based on tooth type, jaw type, and cavity type, it was observed that retention losses were independent of these factors ($p > 0.05$). In the context of marginal discoloration, no restoration received a Charlie score (Table 3). When inter-group comparisons were made, it was observed that Fuji II LC was the most successful material and ChemFil Rock was the least successful material (Table 3). Intra-group assessments of marginal discoloration revealed statistically significant differences within all material groups (Table 3).

None of the restorations received a Charlie score for marginal adaptation (Table 3).

A statistical difference was only observed between the Cention N and ChemFil Rock groups at the 6th ($p = 0.025$) and 12th-month controls ($p = 0.005$) (Table 3). Intra-group assessments of marginal adaptation revealed statistically significant differences within all material groups (Table 3). None of the restorations received a Charlie score for color stability. At the 12th month, only the difference between Equia Forte and ChemFil Rock was significant ($p = 0.041$) (Table 3).

Intra-group assessments of color stability revealed statistically significant differences within the Cention N and ChemFil Rock groups (Table 3). None of the restorations received a Charlie score for anatomical form. Cention N was significantly more successful than other restorative materials in terms of anatomical form (Table 3). Intra-group assessments of marginal adaptation revealed statistically significant differences within all material groups except for Cention N (Table 3).

Secondary caries formation was not observed in any of the groups, and postoperative sensitivity was also absent. In the instances of retention loss, no secondary caries formation was observed in any of the material groups.

Material Months	Equia Forte HT	Fuji II LC	Cention N	ChemFil Rock
1st Month	0	0	0	0
3rd Month	0	1	2	0
6th Month	1	0	1	0
12th Month	0	0	0	1
Total	1	1	3	1

TABLE 1 Distribution of the teeth that showed pulpal infection symptoms by material.

Material		MAXILLARY				MANDIBULARY				
	Localization	First Primary Molar		Second Primary Molar		First Primary Molar		Second Primary Molar		
	Cavity type	MO (n)	DO (n)	MO (n)	DO (n)	MO (n)	DO (n)	MO (n)	DO (n)	TOTAL
	Month									
Failed Equia Forte HT	Baseline	1	11	12	0	1	25	13	1	64
	1st Month	0	0	0	0	1	0	0	0	1
	3rd Month	0	0	0	0	-	1	1	0	2
	6th Month	1	1	0	0	-	2	0	0	4
	12th Month	-	1	1	0	-	2	1	0	5
	TOTAL	1	2	1	0	1	5	2	0	12
Failed Fuji II LC	Baseline	0	8	11	0	1	29	13	2	64
	1st Month	-	0	0	-	0	1	0	0	1
	3rd Month	-	0	0	-	0	0	0	0	0
	6th Month	-	0	0	-	0	1	0	0	1
	12th Month	-	0	1	-	0	0	1	0	2
	TOTAL	0	0	1	0	0	2	1	0	4
Failed Centon N	Baseline	1	7	8	0	2	19	22	3	62
	1st Month	0	0	0	-	0	0	0	0	0
	3rd Month	0	0	1	-	0	4	0	0	5
	6th Month	0	3	0	-	0	0	0	0	3
	12th Month	0	0	1	-	1	2	2	0	6
	TOTAL	0	3	2	0	1	6	2	0	14
Failed ChemFil Rock	Baseline	2	8	11	0	2	15	19	3	60
	1st Month	0	0	0	-	0	0	0	0	0
	3rd Month	0	0	0	-	0	1	1	1	3
	6th Month	0	2	1	-	0	0	0	0	3
	12th Month	0	0	0	-	0	2	2	0	4
	TOTAL	0	2	1	0	0	3	3	1	10

Abbreviations: MO, mesioocclusal; DO, distoocclusal.

TABLE 2 Distribution of restorations by localisation and cavity type.

Discussion

In this study, the clinical success of four different ion-releasing restorative materials in Class II cavities of primary molars that undergone selective caries removal was investigated. Given the vast number of commercially available products marketed as ion-releasing, this study aimed to contrast materials with high fluoride release but different features. Producers have modified the formulation of traditional GICs to enhance their physical characteristics. For instance, Equia Forte HT, which has particles and fillers with close refractive indexes, is considered a glass-hybrid material. The optimised particle size and distribution have improved the material's strength and translucency [Okada et al., 2001; Pereira et al., 2002; Bresciani et al., 2004; Paschoal et al., 2011; Bala et al., 2012; Brkanović et al., 2021; de Lima Navarro et al., 2021]. Additionally, this new GIC demonstrates enhanced fluoride-releasing properties [Okada et al., 2001]. Resin-modified GICs (RMGICs) were developed to overcome some of the problems of early moisture sensitivity and low mechanical strength associated with classical GICs, yet maintain or improve their clinical advantages [Sidhu and Watson, 1995; Sidhu, 2011]. Fuji II LC is one of the first materials marketed as a light-curing GIC, classified as a RMGIC. However, the material still remains popular with its high fluoride release capability and bond strength to

dentin [Eronat et al. 1999; Coutinho et al., 2009; Nagi et al. 2018; Bendgude et al., 2023]. Changes in the formulation of traditional materials included the addition of different metal elements to improve their physical characteristics [Sidhu, 2011; Zoergiebel and Ilie, 2013]. The manufacturer of ChemFil Rock claims an enhanced setting reaction, due to the zinc content as part of its glass particles, leading thus to higher strength [Dentsply, 2011]. Centon N is described by the manufacturer as an "alkasite" and is a derivative of resin-based composites [Todd, 2016]. Centon N was observed to release different levels of F, Ca and P ions and form apatite like crystals. Due to these properties, Centon N has been suggested as a promising material for clinical use [Tiskaya et al., 2019; Ruengrungsom et al., 2020].

Previous research by different scholars has demonstrated that selective caries removal reduces the risk of pulp perforation [Bjorndal et al., 2010; Casagrande et al., 2017; Li et al., 2018; Barros et al., 2020]. Perforation of the pulpal chamber can lead to prolongation of treatment duration [Schwendicke et al., 2015, 2016]. Especially in patients experiencing difficulty with cooperation, prolongation of the treatment duration can be challenging for both the patient and the clinician. In this study, where we chose selective caries removal as the treatment choice, pulpal exposure was observed in 4.58% of the teeth. In other studies this rate was reported as 1.5% in 66 teeth [Franzon et

Variables		Equia Forte HT			Fuji II LC			Cention N			ChemFil Rock		
	Scores Months	Alfa (n)	Bravo (n)	Charlie (n)	Alfa (n)	Bravo (n)	Charlie (n)	Alfa (n)	Bravo (n)	Charlie (n)	Alfa (n)	Bravo (n)	Charlie (n)
Retention	1st Month	63	0	1	63	0	1	62	0	0	60	0	0
	3rd Month	60	0	2	61	0	0 ^d	57	0	5 ^{dq}	53	0	3
	6th Month	54	0	4 ^{tx}	57	0	1	51	0	3	49	0	3
	12th Month	45	0	5 ^{wyz}	52	0	2	42	0	4 ^{wyz}	44	0	4 ^{wyz}
Marginal Discoloration	1st Month	59	4	0	59	4	0	57	5	0	50	10	0
	3rd Month	50	10 ^q	0	55	6 ^e	0	50	7 ^f	0	38	15 ^{efq}	0
	6th Month	34	20 ^{abtx}	0	47	10 ^{aetx}	0	43	8 ^{bft}	0	22	27 ^{eftx}	0
	12th Month	18	27 ^{acwyz}	0	32	20 ^{aewyz}	0	21	21 ^{fwyz}	0	8	36 ^{cefxyz}	0
Marginal Adaptation	1st Month	57	6	0	61	2	0	59	3	0	55	5	0
	3rd Month	51	9	0	51	10 ^q	0	52	5	0	46	7	0
	6th Month	40	14 ^{tx}	0	41	16 ^{tx}	0	44	7 ^{ft}	0	33	16 ^{ftx}	0
	12th Month	24	21 ^{wyz}	0	28	24 ^{wyz}	0	30	12 ^{fwyz}	0	18	26 ^{fwyz}	0
Color Stability	1st Month	62	1 ^c	0	63	0 ^e	0	62	0 ^f	0	54	6 ^{cef}	0
	3rd Month	58	2	0	60	1 ^e	0	57	0 ^f	0	47	6 ^{ef}	0
	6th Month	53	1 ^c	0	56	1 ^e	0	49	2 ^f	0	41	8 ^{cef}	0
	12th Month	43	2 ^c	0	49	3	0	37	5 ^{wy}	0	36	8 ^{cw}	0
Anatomical Form	1st Month	60	3	0	62	1	0	62	0	0	58	2	0
	3rd Month	56	4 ^b	0	59	2	0	57	0 ^b	0	50	3	0
	6th Month	48	6 ^{tx}	0	52	5 ^t	0	50	1	0	46	3	0
	12th Month	39	6 ^{bwy}	0	40	12 ^{dwy}	0	41	1 ^{bdf}	0	33	11 ^{fwyz}	0

Inter-group significant differences; Equia Forte HT-Fuji II LC: a, Equia Forte HT-Cention N: b, Equia Forte HT-ChemFil Rock: c, Fuji II LC-Cention N: d, Fuji II LC-ChemFil Rock: e, Cention N-ChemFil Rock: f. Intra-group significant differences; between 1st and 3rd months: q, between 1st and 6th months: t, between 1st and 12th months: w, between 3rd and 6th months: x, between 3rd and 12th months: y, between 6th and 12th months: z.

TABLE 3 Modified USPHS scores of materials through 12 months.

al., 2014], 0% in 16 teeth [Lula et al., 2009], and 6% in 50 teeth [Orhan et al. 2010]. The difference between studies could be attributed to the variation in sample sizes. The results of the present study showed that a total of six teeth developed pulpal infection after a 12-month follow-up. The success rate regarding the preservation of pulp vitality was found to be 96.73%. Similarly, Franzon et al [2014] reported a 92% success rate after a two-year follow-up in 66 primary teeth using the selective caries removal method. The higher success rate obtained in our study compared

to other studies might be related to the shorter follow-up period. The clinical success of materials is influenced by factors such as patients' bruxism, dietary habits, brushing practices, etc. Therefore, split-mouth studies are recommended for investigating the clinical success of different materials [Hickel et al., 2007]. Although our study did not qualify as a complete split-mouth due to the challenge of having four primary molars with identical caries characteristics in the same patient, the majority of restorations (65.4%) were performed using three or four different

restorative materials in the same patient. Although not a complete split-mouth design, our results are mostly applicable to clinical dentistry when considering patient factors.

In terms of retention, at the end of the study, Fuji II LC had the highest success rate with only 7.14% failure, while Cention N had the lowest success rate, with a 25% failure. The higher failure rate in the Cention N group could be associated with the choice of not using an adhesive system. In this study, an adhesive system was not used based on the manufacturer's statement, which indicated that Cention N could be applied without an adhesive system, and to standardise the single-step application of all restorative materials into the cavity. Cention N can be applied with or without an adhesive system for primary teeth, as specified by the manufacturer. In a study conducted by Cunha et al. [2022] on primary molars, the one-year survival rate of Cention N was reported to be 66.7%. However, when Cention N was used with an adhesive system, this rate was reported to increase to 70.4%. Considering this, it can be suggested that using Cention N with an adhesive system may yield to better success rates. However, the adhesive layer between the dentin and the material could affect the fluoride release adversely [Wiegand et al. 2007]. The retention loss in the Equia Forte HT group was 21.05%. In a study conducted on primary molars the previous version of Equia Forte HT, Equia Forte, was used as a restoration material, and the authors reported a failure rate of 17% [Kupietzky et al., 2019]. In another study failure rate of Equia Forte was reported as 25.6% while the failure rate of ChemFil Rock was reported as 13.4% after one year of follow-up [Gok Baba et al., 2021]. They attributed the lower success in Equia Forte to the inability to apply Equia Coat on the approximal surfaces, which resulted in early moisture contact. The results obtained for Equia in both studies were similar to ours.

In the present study, the ChemFil Rock group showed 18.51% failure. Similar to the findings of Gok Baba et al. [2021] (13.4% failure), it appears that ChemFil Rock is more successful than Equia Forte and Cention N in terms of retention. The zinc in the structure of ChemFil Rock is suggested to enhance the material's mechanical properties by initiating the hardening reaction early and causing zinc oxide formed during hardening to modify the glass network, leading to increased exposure to acid attacks [Zoergiebel and Ilie, 2013]. However, when compared to other materials, no significant superiority of ChemFil Rock material was found in our study. Regarding the marginal discoloration, there was significantly more frequent occurrence of Bravo scores in the ChemFil Rock group compared to the other three groups. In contrast to our study, Gök Baba et al. [2021] reported no significant difference between Equia Forte HT and ChemFil Rock. In another study, comparing Cention N and Fuji II, it was stated that all restorations received an "Alpha" score for both marginal discoloration and marginal adaptation [Arora et al., 2022]. When evaluating marginal adaptation in our study, the difference only between Cention N and ChemFil Rock was significant. Similar to our findings, Gok Baba et al. [2021] found no statistical difference between Equia Forte and ChemFil Rock in terms of marginal adaptation. In contrast with our findings, Ballal et al. [2023] reported that Cention N showed significantly better marginal adaptation, anatomic form, and color stability compared to RMGIC. The difference between studies could be attributed to the use of different RMGIC brands. It is not possible to fully compare these studies to ours due to differences in study design and samples.

Equia Forte HT showed the highest success as far as color stability, while the ChemFil Rock showed the least success. There was a significant difference between ChemFil Rock and all other

materials. This difference in color stability may be attributed to the high surface roughness of the ChemFil Rock material [Kumar et al., 2021]. Unlike our findings, some authors stated that there was no significant difference between these materials in terms of color stability [Gok Baba et al. 2021; Arora et al., 2022].

Cention N showed the best results for anatomical form in our study. Some researchers also mention that the anatomical form criterion may not be crucial for restoration success in primary teeth [Gok Baba et al. 2021]. Secondary caries formation and postoperative sensitivity were not observed in any of the groups in the present study. While the high fluoride content in the materials we used may have contributed to this, it should be noted that the one-year follow-up duration might limit the observation of secondary caries formation. The previous studies also reported that secondary caries was not observed [Gok Baba et al. 2021; Arora et al., 2022]. Regarding postoperative sensitivity, Gok Baba et al. [2021] reported one case each for both ChemFil Rock and Equia Forte. Based on these findings, it can be suggested that while the materials used in this study demonstrate promising outcomes in minimizing postoperative sensitivity, longer follow-up periods are essential to confirm their effectiveness in preventing secondary caries formation. The inability to design the study as a split-mouth study due to limited resources is among the limitations of the research. Another limitation is that, despite the selection of similar carious cavities, achieving complete standardisation was not entirely possible.

Conclusion

Although the superiority of the materials over each other could not be proven clearly, Fuji II LC appears to be more successful in terms of retention, which is an important criterion for clinical success. Additionally, selective caries removal appears to be a successful treatment method for the restoration of primary teeth within the limitations of this study.

Author Contributions

ZBB contributed to conception and design, acquisition, and interpretation of the data and critically revised manuscript. ZZC contributed to conception and design, analysis, and interpretation of the data and critically revised manuscript. AC contributed to acquisition and interpretation of the data drafted and critically revised manuscript. HK contributed to design, analysis of the data, and critically revised manuscript. All authors gave their final approval and agree to be accountable for all aspects of the work.

IRB Approval

This study is approved by the Ethical Committee for Clinical Research of Akdeniz University.

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Conflict of Interest Statement

Authors have no conflict of interest to declare.

Data Availability Statement

The data supporting this study's findings are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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