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Original Article

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Non-restorative cavity control on proximal carious lesion of primary maxillary incisors

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ABSTRACT

BACKGROUND & OBJECTIVE: Early childhood caries (ECC) is a high-prevalence infectious disease with significant unmet dental care needs globally. This study aimed to compare the clinical success rates of nonrestorative cavity control (NRCC) using disking with a restorative approach (RA) using a resin-modified glass ionomer (RMGI) restoration on the proximal surfaces of the primary maxillary incisors with dental caries.

METHODOLOGY: 108 proximal caries in 42 children aged 3–5 years met the inclusion criteria; caries were limited to the outer to middle third of the dentin with no pulpal or periapical pathology. The study included two experimental groups: the NRCC group was treated with proximal disking and applying 5% sodium fluoride varnish, while the RA group received RMGI Class III restorations. The follow-up period was 20 months. The 20-month cumulative survival rates were estimated using the Kaplan-Meier survival analysis, and the differences between the groups were analyzed using the Log-rank test.

RESULTS: The cumulative survival probability for the NRCC group was 71.4%, while the RA group demonstrated a 71.7% success rate after 20 months. The survival probabilities between the two caries management modalities were similar ($p = 0.963$).

CONCLUSION: The clinical success rates of NRCC using disking or RA using RMGI on the proximal caries surfaces of the primary maxillary incisors were similar.

KEYWORDS: Caries Management, Dental Caries, Non-restorative Cavity Control, Primary Dentition.

INTRODUCTION

Early childhood caries (ECC) is a very prevalent (30% -82%) disease involving children below six years old worldwide [1,2]. ECC can negatively impact the quality of life of preschool children [3] and burden their families [4,5]. Primary maxillary incisors are usually the most vulnerable to ECC and are affected prior to the posterior teeth [6]. Due to multiple carious lesions in ECC, the young age of the patients leading to low cooperation, and the high cost of dental treatment, most carious lesions go untreated [4,7]. Therefore, it is essential to investigate a simple alternative method for controlling the progression of carious lesions.

According to the current concept based on the "Ecological plaque hypothesis", caries is the consequence of an unfavourable shift towards demineralization by acid produced by bacteria [8]. Thus, the caries process should be disrupted by modifying the environment to favour remineralization. Therefore, contemporary caries management includes nonrestorative strategies. For the primary anterior teeth, silver diamine fluoride (SDF) has been well-documented for its efficacy in arresting caries progression [9]. However, a main drawback of SDF application on primary maxillary incisors is its non-esthetic black staining because of silver phosphate precipitation [10]. Another nonrestorative approach is nonrestorative cavity control (NRCC), which aims to preserve the primary tooth without pain or periapical pathology until its natural exfoliation [11].

According to Peretz and Gluck, disking on the primary anterior teeth could arrest the caries progression [12]. A recent retrospective study demonstrated the effectiveness of this approach, revealing successful caries arrest in 76% of participants during a follow-up period of at least 6 months [13]. Nevertheless, there is a paucity of clinical studies assessing the applicability of this intervention on primary maxillary incisors.

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This study aimed to evaluate and compare the clinical success rates of NRCC using disking with the conventional class III resin-modified glass ionomer (RMGI) restoration on the proximal surfaces of the primary maxillary incisors in preschool children. The null hypothesis is that there is no difference in the survival estimates between the NRCC and the RA on the proximal surfaces of the primary maxillary incisors in preschool children at the 20-month follow-up. In addition, the time spent on the dental procedures, the children's behaviour, postoperative pain, and the acceptability of the child's appearance were evaluated.

METHODOLOGY

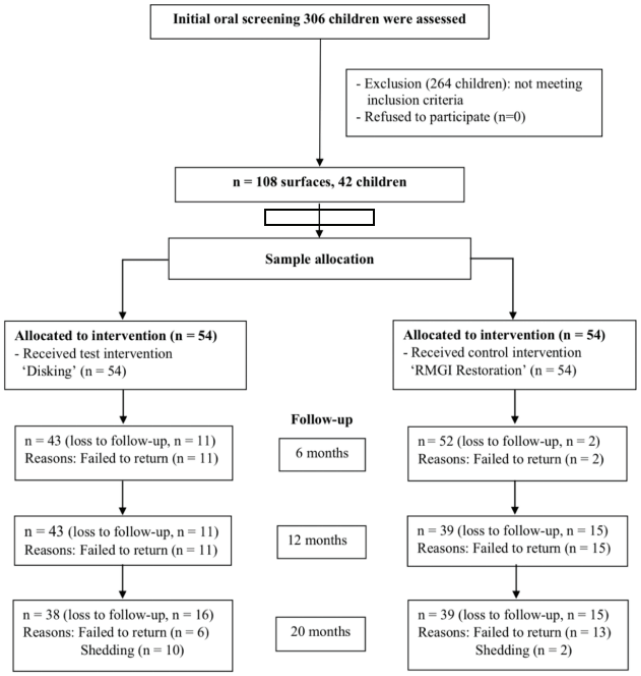
The study was conducted in compliance with the requirements of the Declaration of Helsinki and was approved by the Ethics Committee of the Faculty of Dentistry, Chulalongkorn University, Bangkok, Thailand (Ethical Approval Number: HREC-DCU 2018-021). After the verbal explanation and discussion of risks and benefits with the caregivers, written informed consent was obtained for the children who participated in the study prior to the investigation.

This 2-arm, parallel-experimental group was performed from October 2018 to January 2021 in 2 villages in northern Thailand. By using a group-matched comparative design with alternate allocation, the children were assigned to 1 of the two arms: NRCC (disking/ intervention group) or RA (resin-modified glass ionomer class III restorations/ control group) on cavitated proximal caries in primary maxillary incisors. The children were excluded if they had medical health problems, pain, or signs or symptoms of pulpal or periapical pathology. The participants were match-paired based on the type of tooth (central or lateral incisors) and the depth of the proximal caries on their preoperative radiograph. Patient recruitment and follow-up are presented in Figure I (adapted from Schulz KF et al.) [14].

The sample size was calculated based on Chu et al.'s study measuring the effectiveness of topical fluoride application in arresting dentin caries [15] using a randomized control trial for binary data formula (n4Studies application version 1.4.1 for iOS). The calculations incorporated a 5% probability of type I error and 80% power. For this study, an examination of forty-eight cavities was required.

The inclusion criteria for the participants in the study were healthy 3–5-year-old preschool children (American Society of Anesthesiologists Class I), no allergy to colophony, co-operative or potentially co-operative behaviour, having closed contacts between the primary maxillary incisors with cavitated proximal caries limited to the outer-to-middle third of the dentin without periapical pathology noted on a periapical radiograph. A pediatric postgraduate student (1st dentist) screened 306 preschool children. Subsequently, 42 preschool children met the criteria. All children received tooth brushing after lunch with 1,000-ppm fluoride toothpaste and biannual 5% sodium fluoride varnish application as part of the regular preventive program at the child development centres.

Figure-I: Experimental design and participants' progression throughout the study.



At the beginning of the study, parents completed a questionnaire examining their child's demographic background and oral health behaviors. Afterward, the children were examined using the WHO examination criteria [16] in a mobile dental unit by the first dentist. The intra-examiner weighted kappa value was 0.98 (Table-I). The dental plaque score was collected using a modified Greene and Vermillion's Simplified Oral Hygiene Index (OHI-S) [17]. The intra-examiner weighted kappa value was 0.83. For imaging the maxillary anterior teeth, No. 2 ultra-speed dental film (Kodak®) was employed with bisecting technique. The long cone X-ray machine utilized for this purpose was Belmont®, Phot-X IIs. Following the image acquisition, the films underwent manual processing. The radiographs were analyzed and scored by one senior pediatric dentist (2nd dentist) using a standard viewing box with a constant light source and a 4.5X magnifying glass. The radiographic examination evaluated the depth of the carious lesion. The lesions were classified into four categories: outer-, middle-, or inner-third of the dentin and periapical pathology. The intra-examiner weighted kappa value was 0.91.

The dental treatment was performed by the 1st dentist in a clinical setting. No local anesthesia was administered. A Molt mouth gag and rubber dam were used in each case. The child's behavior during treatment and the duration of the treatment procedure were recorded. A toothbrush and 1,000 ppm fluoride toothpaste were provided for the child to use during the study period. The child's other dental treatment needs were met at local health centers before the first 6-month follow up. For NRCC group, a high-

speed air turbine needle #852-010 diamond-bur was used to open the contact area approximately 1 mm. and dentin caries was unexcavated. For RA group, a high-speed air turbine diamond #001-010 round-bur was used to prepare a slot preparation on the proximal surface [18]. The dental caries were removed and restored with resin modified glass ionomer cement (Fuji II LC®) per the manufacturers' instructions. After both treatments, 5% sodium fluoride varnish (Duraphat®) was applied on the disking surface and all teeth. After treatment, the parents' satisfaction with the child's esthetic appearance was evaluated using a 5-Point Likert Scale [19]. The child's pain perception was determined regarding tooth pain and tooth sensitivity at 1- and 7-days post-treatment by a telephone interview with their parents.

The postoperative evaluations were originally planned to be conducted at 6-, 12-, and 18-month post treatment. However, due to the closure of the child development center resulting from the Covid-19 pandemic, the 18-month follow-up was extended to 20-month. The clinical evaluations were conducted by a trained external researcher (3rd dentist). The intra-examiner weighted kappa value was 0.95. A disking surface was considered a success when the disking surface was easily visualized as brown, black, shiny, and hard on probing with gentle pressure.

In contrast, the disking surface was considered a failure when active caries was observed, or when the pulp was inflamed with or without a fistula/ abscess. A GI restoration was considered a success when the restoration was still present with good marginal adaptation. Failure was defined as when there was a defect in the filling, when secondary caries was observed, when the restoration was not present, or when the pulp was inflamed with or without a fistula/ abscess, or the tooth was extracted. In both groups, when the tooth shed naturally without pathology, it was considered as success. Post-operative radiographs were taken at the 6- and 20-month follow-ups. The films were assessed by the second dentist to examine lesion depth and for the presence of periapical pathology.

The data were analyzed using Statistics Package for Social Science (SPSS) for Windows, version 22.0 (SPSS Inc., Chicago, Illinois, USA). Intra-examiner reliability was calculated by the weighted Kappa test (Table-I). The categorical variables are presented as numbers (percentage) and compared using the Chi-square test or Fisher's Exact Test as appropriate. The continuous variables are presented as means (standard deviations, SD) and the differences between the groups were compared using the Independent T-Test or Mann-Whitney U Test as appropriate. The Kaplan-Meier method was used to analyze survival curves and Log rank test was used to compare two different curves. Furthermore, the subjects were categorized regarding pre-operative caries experience into dmft ≤ 4 and dmft ≥ 5 groups, and the survival probabilities were also compared using the Kaplan-Meier survival analysis and Log-rank test. The significance level was set at $p < 0.05$.

RESULTS

Table-I: Intra-examiner reliability measures.

Dentist	Measurement	Kappa Values
First	dmft	0.98
First	Simplified Oral Hygiene Index (OHI-S)	0.83
Second	Radiographic interpretation	0.91
Third	dmft	0.95

Abbreviations: dmft, decayed, missing, and filled teeth in primary dentition.

Table-II: Background variables based on the treatment protocol group, n (%).

Background variables	NRCC/Disking	RA/RMGI	P-value
Median age	3	3	0.304*
Mean OHI-S score ± SD	1.1 ± 0.4	1.1 ± 0.4	0.913**
Sex Boys Girls	 11 (52.4) 10 (47.6)	 7 (33.3) 14 (66.7)	0.212†
Frequency of tooth brushing < 2 time/ day ≥ 2 time/ day	 3 (14.3) 18 (85.7)	 6 (28.6) 15 (71.4)	0.454‡
Between meal carbohydrate intakes < 3 time/ day ≥ 3 time/ day	 15 (71.4) 6 (28.6)	 15 (71.4) 6 (28.6)	1.000†
Type of teeth Primary upper central incisors Primary upper lateral incisors	 42 (77.8) 12 (22.2)	 42 (77.8) 12 (22.2)	1.000†
Depth of caries Dentin outer third Dentin middle third	 33 (61.1) 21 (38.9)	 33 (61.1) 21 (38.9)	1.000†
Behavior during treatment co-operative potentially co-operative	 21 (100.0) 0 (0.0)	 18 (85.7) 3 (14.3)	0.232‡

*** Mann-Whitney U Test**
**** Independent T-Test**
† Chi-square test
‡ Fisher's Exact Test

The treatment performed from October-November 2018 and the 20-month follow-ups were completed in January 2021. The post-operative evaluations were performed after 6, 12, and 20 months. At the beginning of the study, fifty-four pairs of class III cavities on the proximal surface of the primary maxillary incisors of 42 children were matched paired. The mean dmft of the participants was 5.1 ± 2.9 (Table-II). At baseline, the background variables, including sex, age, mean OHI-S score, between-meal carbohydrate intake, and the frequency of fluoride exposure from fluoride-containing toothpaste and professionally-applied topical fluoride, did not exhibit statistically significant differences between the two study groups. The average operating time for disking and a class III restoration with GI was 1.2 and 5.6 minutes per cavity, respectively.

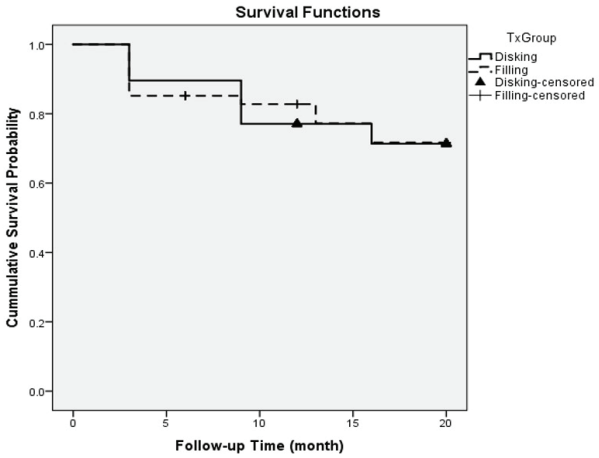
The major failures in the NRCC group were active caries (6 surfaces), whereas, a dislodged restoration (9 restorations) and secondary caries (4 restorations) were found in the RA group (Table-III). The clinical examination demonstrated that heavy dental plaque accumulation was present on unsuccessful disking surfaces. The Kaplan-Meier survival analysis and Log rank test were performed. The NRCC group demonstrated cumulative survival probabilities of 89.6% at 6 months, 77.1% at 12 months, and 71.4% at 20 months. The RA groups demonstrated a success rate of 85.2%, 82.8%, and 71.7% at 6, 12, and 20 months, respectively. The survival rate in the NRCC group was not significantly different from that of the RA group (p = 0.963), presented in Figure-II. The median survival times for the NRCC and RA groups were more than 20 months. Moreover, the Kaplan-Meier survival outcomes established on baseline caries severity. The lack of significant differences (p = 0.272 and 0.229 for the low and high dmft groups, accordingly) recommended that stratification by dmft levels may not have a considerable impact on treatment efficacy within the study's scope.

Table-III: Clinical success based on the treatment protocol group, n (%).

Follow up period	NRCC/Disking	RA/RMGI	P-value
6-month follow up			
N evaluated	43	52	
Success	38 (88.4)	44 (84.6)	0.596*
Failure	5 (11.6)	8 (15.4)	
12-month follow up			
N evaluated	43	39	0.841*
Success	36 (83.7)	32 (82.1)	
Failure	7 (16.3)	7 (17.9)	
20-month follow up			
N evaluated	38	39	
Success	32 (82.1)	26 (66.7)	0.074*
Failure	6 (15.9)	13 (33.3)	

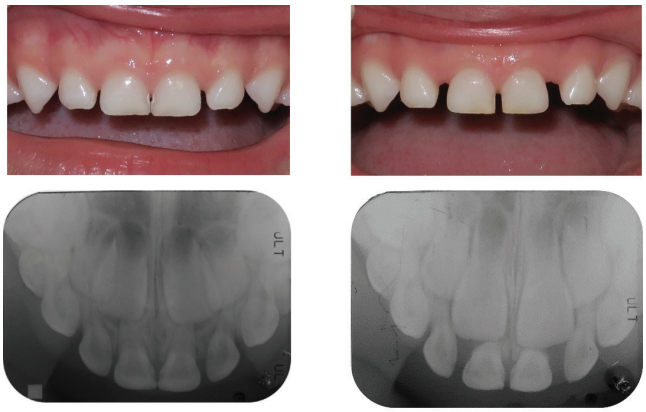
*** Chi-square test**

Figure-II: Kaplan-Meier survival estimates between the clinical outcomes of the NRCC/disking and RA/RMGI restoration on the proximal surfaces of primary maxillary incisors (Log-rank test p = 0.963).



Although, NRCC by disking created spacing between the teeth (Figure-III), the parents were satisfied with their child's appearance (mean rating score = 4.2). In addition, no pain or tooth sensitivity was reported.

Figure-III: Clinical and radiographic appearance of disking teeth at baseline (A) and 20-month follow-up (B).



(A) (B)

DISCUSSION

Nonrestorative caries management is currently recognized as an integral component of contemporary dental caries treatment strategies. In our study, the predetermined sample size was a minimum of 24 surfaces for each group. Upon the completion of the 20-month study, we assessed 38 surfaces in NRCC and 39 surfaces in RA group. From the initial oral screening of 306 children, only 42 children met the inclusion criteria. At baseline, the background variables between the two study groups concerning sex, age, mean OHI-S score, between meal carbohydrate intake, and frequency of exposure to fluoride were not significantly different. The subgroup analysis of pre-operative caries experience revealed that there were no significant differences in the survival rate between the NRCC and RA groups among children with dmft ≤ 4 and those with dmft ≥ 5. Therefore, the differenced in pre-operative caries experience could not attribute to the clinical success in each treatment modality. To confirm the impact of dmft on success rate both treatment rational, additional study should be performed in a larger and different population.

A recent retrospective study illustrated the efficacy of disking in primary maxillary incisors in arresting caries, with a success rate of 76% among participants at a follow-up of at least 6 months [13]. In our study, the post treatment evaluations were originally planned to be conducted at 6-, 12-, and 18-month post-operative. However, the child development centers were closed during the Covid-19 pandemic, the 18-month follow-up was extended to 20-month.

The success rate at the end of the study for NRCC and RA was 71.4%, and 71.7%, respectively. Comparing the survival rates with previous clinical trial found that the survival rate of class III GI restorations ranged from 65%-88% after 1 year [20]. In our study, the Kaplan-Meier survival analysis and

Log-rank test results indicated that the cumulative success rate in the NRCC group was not significantly different from that in the RA group (p = 0.963) at the 20-month follow-up. So, the clinical success rate of both treatment rational were similar. Disking could inhibit caries progression by creating the space between the teeth that enabled the immediate application of 5% sodium fluoride varnish directly onto the carious lesion. In the presence of fluoride, fluorapatite crystals are formed, which are more resistant to acid dissolution [21].

In addition, the biannual 5% Sodium fluoride application used in child development centers regular preventive program and home-use of a fluoride-containing dentifrice could contribute to the success of remineralization on the disking surfaces. Moreover, fluoride could reduce the post-operative tooth sensitivity on disking surface by reduction or block fluid movement in the dentinal tubules [22]. In our study, the failure rate in the NRCC at the 20-month follow-up was 15.9%. The major failures in the NRCC group were active caries. The clinical examination demonstrated that heavy dental plaque accumulation was present on the unsuccessful disking surfaces. Our results confirmed the previous research that proximal disking should be accompanied by a preventive regimen, including good hygiene care, proper eating behavior and professional topical fluoride [12]. Further investigations should explore the possible factors that contribute the plaque accumulation such as frequency of oral hygiene practice, frequency and duration of carbohydrate intake, and role of caregivers on supervised toothbrushing.

NRCC using disking is a simple procedure that requires minimal operating time. The mean operating time for disking was 1.2 min per cavity compared with 5.6 min for one class III restoration with RMGI. The operating time in the RA group was significantly longer than that in the NRCC group. During the treatment, the children in both groups demonstrated co-operative behavior, and accepted the dental treatment. This might have been because the operator was a trained postgraduate pediatric dentist and the participants were rural children. The skilled dentist could use the appropriate behavior guidance techniques that build good rapport with children for more cooperation.

Furthermore, Sivakumar and Gurunathan illustrated that children living in rural areas or in the lower middle class were extremely cooperative during dental care [23]. Regarding patient satisfaction with NRCC using disking, the parents expressed contentment with their child's appearance with the presence of small gap between the front teeth. The esthetic acceptance might not be the same in different culture and socioeconomic groups, so more research should be conducted. In addition to its efficacy, NRCC using disking should be favored to preschool children and their parents due to its less invasive nature, no local anesthetic injection, and ultra-short procedure. Thus, disking could serve as an interim treatment for uncooperative children with ECC on upper incisors who have no access for advance treatment. Furthermore, NRCC using disking could be a simple effective option to manage the progression of dental decay in children living in communities with low resource settings.

Finally, our study had some limitations such as (1) number of samples is not large enough for generalization, (2) lack of blinding on treatment procedure, operator, and radiographic interpretation, and (3) short follow-up period. Future research should be conducted on multi-centers study randomized control trail, different levels of children behavior, various dentist competency, a broader range of culture and socioeconomic groups, the environment with and without topical fluoride usage and longer follow-up time until the teeth exfoliate naturally.

CONCLUSION

In the context of topical fluoride use, the NRCC using disking, inhibits caries progression in carious proximal surfaces on the primary maxillary anterior teeth in preschool children. The cumulative survival probability for NRCC group was 71.4% at the 20-month follow-up, suggesting the effectiveness of disking as the option of nonrestorative caries management. In addition, the oral hygiene practice for plaque removal should be emphasis to caregiver.

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Authors' Contribution:

Niwat Thanaboonyang: Data acquisition, analysis, interpretation of data, drafting and critically revised the manuscript.

Busayarat Santiwong: Design the work and critically revised the manuscript.

Pornpun Asvanit : Contribution to the conception, design the work, data acquisition, interpretation of data, drafted and critically revised the manuscript.

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