

Effectiveness of silver diamine fluoride in arresting early childhood caries: a randomised controlled clinical trial



R. K. ElGhandour¹, M. M. H. ElTekeya²,
A. A. Sharaf²

¹ Pharos University in Alexandria, Egypt
² Alexandria University, Egypt

DOI 10.23804/ejpd.2024.2052

Email: rabab.elghandour@pua.edu.eg

Abstract

Aim Evaluate the effectiveness of biannual 38% SDF in arresting early childhood caries (ECC) compared to atraumatic restorative treatment (ART).

Methods One hundred children (aged 2-5 years) with ECC were (2-5 years) divided equally and randomly into two groups. Test group: 38% SDF biannually; Control group: ART. The primary outcome was caries arrest/arrest, which was assessed at the 3,6,9, and 12 months interval. Oral health-related quality of life (OHRQoL) was evaluated at base line and after 12 months using the Parental-Caregiver Perceptions Questionnaire (P-CPQ) and Family Impact Scale (FIS).

Statistics Chi-Square and Fisher's Exact tests were used to compare all qualitative variables. Non-parametric Mann Whitney U test was used for quantitative data.

Results After 12 months, SDF and ART groups showed 94.4% and 34.3% overall success, respectively ($P<0.0001$). Success of anterior teeth was 95.7% for SDF and 28.2% for ART ($P<0.0001$) while in posterior teeth was 92.9% for SDF and 42.3% for ART ($P<0.0001$). The mean difference in scores of P-CPQ domains was 3.16 ± 2.71 in the SDF group and 2.98 ± 2.85 in the ART group ($P>0.05$). The mean difference in scores of FIS domains was 1.84 ± 2.19 in the SDF group and 1.10 ± 1.91 in the ART group ($P>0.05$).

Conclusions SDF was considerably more effective in arresting ECC after 12 months compared to ART. An overall significant improvement of OHRQoL was reported for both groups with SDF being faintly superior to ART.

Introduction

Multiple obstacles stand in the way of successful management of early childhood caries (ECC) such as: high costs, very young age of patients, relying on parental compliance and the need for specialised team and sophisticated equipment. If left untreated, ECC leads to long term and even serious consequences as well as compromised oral health related quality of life (OHRQoL) of children and their families [Colak et al., 2016]. Atraumatic restorative treatment (ART) means that caries removal is done using hand instruments only followed by an adhesive restoration, mainly glass ionomers (micromechanical interlock and true chemical bond). This method was initially meant to provide dental care where electricity, piped water and financial resources were not available. Later, after providing notable success, ART was approved by the World Health Organization in 1994 and is currently regarded as high-quality dental care that is not

KEYWORDS Early childhood caries, silver diamine fluoride, atraumatic restorative treatment, minimal invasive dentistry.

restricted to developing countries nor underprivileged communities. It is minimally invasive, can be accomplished in non-dental settings and since it does not involve drilling nor anaesthesia, is well accepted by young children. However, the success range of ART is very broad and is dependent on multiple factors; operator skills, child cooperation, amount of caries removal, and restorative material used. Besides, it has limited success in anterior teeth and multi-surface lesions. Furthermore, despite its simple technique, it still demands a certain amount of time from trained dentists [Frencken et al., 2012]. An innovative approach was thereby needed in order to control ECC while at the same time overcome the drawbacks of ART. Evidence is solidly growing regarding the effectiveness of SDF in arresting dentin caries. SDF has been used in dentistry since the 1960s [Yamaga, 1969], and has been approved by the Food and Drug Administration (FDA) in the USA in 2014 as a medicament for tooth hypersensitivity and since 2018 is being used "off label" as an anti-caries medicament [Administration]. It is easy to apply, even by non-dental personnel and/or in non-dental settings and is relatively affordable. Moreover, since SDF application does not require caries removal, it is well accepted even by young children. Despite the safety of SDF, a main disadvantage is the black staining of demineralised or cavitated surfaces. However, parents did not seem to mind this side effect, as long as there was absence of pain and dental infection, especially at times when access to dental care is challenging [ElGhandour et al., 2021]. This study aimed to evaluate the effectiveness of SDF in arresting ECC in comparison to ART. The null hypothesis was that there are no differences between SDF and ART regarding their caries arresting potential and their impact on the OHRQoL.

Methods

This study is a randomised controlled clinical trial with a 1:1 allocation ratio [NCT04514094 - ClinicalTrials.gov]. It was approved by the Research Ethics Committee in the Faculty of Dentistry, "Alexandria University" (19.8.2018) consistent with the Declaration of Helsinki standards. Parents received comprehensive explanation of the nature of the study, the significance of managing ECC, the probability that their child might join either group of the trial along with emphasising - with pictures - the black stain accompanying SDF as well as

possible staining of gingival tissues and/or clothes. Parents signed 'an informed consent' declaring their willingness to let their child join the trial while sustaining the right to refrain from the trial at any point. Forty-six children per group were needed to generate a statistically meaningful outcome based on a 5% statistical significance level, 80% power and on the results of Dos Santos et al. [2012] where a 30% difference in success rates of both groups was reported. The sample was boosted to 50 children per group to make up for possible losses. Calculations were done using an online software (Power and Sample Size, HyLown Consulting LLC, Atlanta, GA, USA). Participants were recruited from the outpatient clinic, Faculty of Dentistry, "Alexandria University"; those who were referred to dental rehabilitation under general anaesthesia after failing to cooperate during traditional restorative procedures and whose parents were reluctant with the option of general anaesthesia or those with long waiting times.

Eligibility criteria for children

Healthy and free from systemic diseases or known allergies; between 2 and 5 years old; diagnosed with ECC.

Eligibility criteria for teeth

Teeth with distinct/extensive distinct cavities with visible dentin corresponding to scores 5 and 6 of the International Caries Detection and Assessment System II (ICDAS II) detection codes; active lesions that are soft/leathery on gentle probing according to ICDAS II activity criteria for coronal primary caries; no signs of pulpal involvement (pain, abscess, fistula, obvious discoloration, premature hypermobility, internal or external root resorption) [Dikmen, 2015, Ismail et al., 2007].

Participants were arbitrarily and evenly assigned using a simulated list of random numbers (Random Allocation Software, version 1.0.0), to either the SDF or the ART group. A trial independent intern gave each participant a serial number representing his/her allocation and put a duplicate of this number in an opaque envelope that was opened only at the time of intervention; so that the group to which the child was allocated was concealed from the investigator.

Blinding of examiners or patients was not possible neither during intervention nor follow-up due to the different nature of the materials. However, the statistician who analysed the results, did not know the group to which the data belonged.

The main investigator received training regarding ICDAS II scoring, application of both materials and evaluation of outcomes. For intra-examiner reliability, ten cases—not included in the study—were examined twice by the main researcher. Levels of intra-examiner agreement using Cohen's Kappa index were 0.75 and 0.72 for SDF and ART, respectively. Inter-examiner reliability was assured between the main researcher and supervisors by examining the ten cases. The Kappa index of inter-examiner agreement among the two pairings of the three examiners ranged from 0.68 to 0.80 for SDF and 0.72 to 0.83 for ART. Baseline screening was done for all patients by one calibrated examiner between September and November 2018, under the same dental setting (standard light source, 2-way syringe and suction device). Demographic data, medical history, dental history, oral health related habits and caries experience—represented by dmft score—were recorded in the patients' progress sheet. Children received intervention to all their eligible teeth according to their assigned group as follows.

Study group (SDF)

38% SDF (Advantage Arrest Silver Diamine Fluoride 38%, Elevate Oral Care USA) was applied at baseline and after 6 months; gross debris was removed with cotton pellets; cotton rolls were used to protect surrounding tissues; affected tooth surfaces were dried with a gentle flow of air; SDF was then applied using a micro sponge brush; if the behaviour allowed, the SDF was left to dry for 1 minute or it was covered with petroleum jelly to avoid being washed away. After 2-4 weeks, reapplication was done only to lesions with persistent activity (not darkened and/or hardened).

Control group (ART)

Caries removal by hand instruments was done mainly from the periphery of lesions with care not to expose the pulp; cotton roll isolation; cavities were restored by high viscosity glass ionomer cement (GC Fuji IX, GC America); hand pressure was then applied by a gloved and petroleum jelly coated finger, then, excess material was removed.

Children were instructed to avoid eating, drinking or rinsing for at least one hour after intervention. Parents and children received age-appropriate oral hygiene instructions and were advised to minimise snacking and avoid consuming a carbohydrate-rich diet. Teeth not meeting the inclusion criteria, failed teeth or new carious lesions appearing at any point of the course of the study were treated as necessary by the investigator. For the SDF group, alternating between SDF and fluoride varnish application was done every three months. For the ART group, fluoride varnish was applied every three months.

The primary outcome was caries arrest and this was assessed for all included teeth at every recall appointment. A tooth with arrested caries was marked as 'success' while, if a lesion was reported as active along with lesions that required further intervention as restoration, pulp therapy, or extraction or teeth showing negative outcomes such as pain or signs of infection were counted as 'failure'. For the SDF group, caries activity judgment was based on lesion color and texture. Dark, hard dentin that is resistant to probing indicated caries inactivity (success), while a dentinal lesion that was easily penetrated with a probe when employed with light force, was considered an active lesion (failure). [Miller, 1959] For the ART group, teeth were evaluated for clinical success according to the "ART Evaluation Criteria", where only intact restorations with a marginal deficiency less than 0.5 mm corresponding to scores 0 and 1 were considered successful; those with scores 2–9 and "C" were counted as failures [Phantumvanit et al., 1996].

The secondary outcome was oral health related quality of life. Assessment was done through the short-term versions of two questionnaires addressed to parents at baseline, and after 12 months [Al-Riyami et al., 2016; Thomson et al., 2013] as follows:

- A. Parental-Caregiver Perceptions Questionnaire (P-CPQ): Sixteen closed-ended questions, subgrouped into four domains; oral symptoms, functional limitations, emotional well-being, and functional well-being.
- B. Family Impact Scale (FIS): Eight items subgrouped into three domains: parental/family activity, parental emotions, and family conflict.

For both questionnaires, each response was scored as follows: (0) never/ don't know, (1) once or twice, (2) sometimes, (3) often and (4) every day or almost every day.

Statistical analysis

All analyses were performed with an "intention to treat

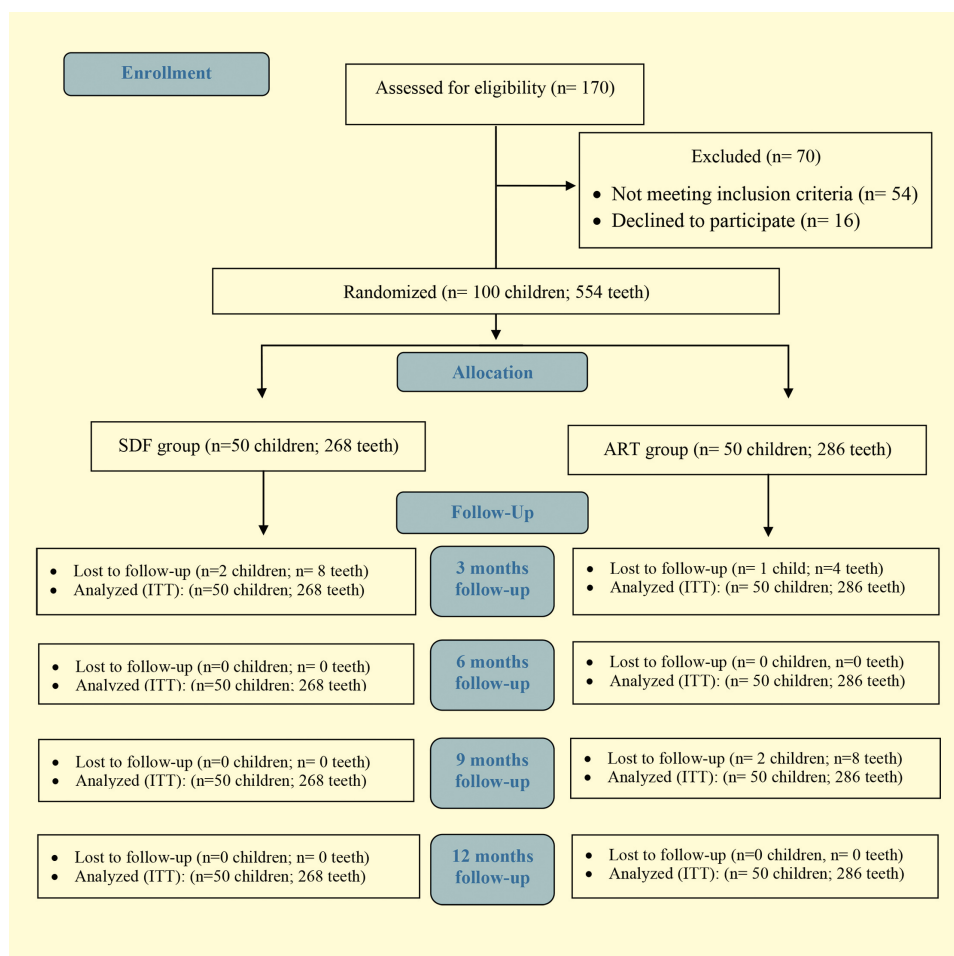


FIG. 1 Flow diagram of the trial.

analysis". Chi-Square and Fisher's Exact tests were used to assess differences between study groups concerning all qualitative variables. Non-parametric Mann Whitney U test was implemented to measure differences in quantitative data. Data were analysed using IBM SPSS software package version 25.0. (IBM Corp, Armonk, NY, USA).

Results

One hundred children were enrolled in the study, with 554 teeth meeting the inclusion criteria (SDF N=50 n=268, ART N=50, n=286). Both groups were homogenous at baseline (Table 1). Two SDF patients (8 teeth) were lost after 3 months. One ART patient (4 teeth) was lost after 3 months and two more ART patients (8 teeth) were lost after 9 months (Figure 1). After six months, SDF and ART groups showed 94.8% and 78% overall success, respectively ($P<0.0001$). Success of anterior teeth was 95.7% for SDF and 68.1% for ART ($P=0.001$). Success of posterior teeth was 93.7% for SDF and 91.1% for ART ($P=0.430$). After twelve months, SDF and ART groups showed 94.4% and 34.3% overall success, respectively ($P<0.0001$). Success of anterior teeth was 95.7% for SDF and 28.2% for ART ($P<0.0001$). Success of posterior teeth was 92.9% for SDF and 42.3% for ART ($P<0.0001$) (Table 2, Figure 2). The total P-CPQ mean score was reduced from 10.76 ± 3.43 pre-operatively to 7.6 ± 2.42 at the end of the study among the SDF group and from 10.16 ± 3.62 to 7.18 ± 2.27 among the ART group. Speaking of each group on its own, these results have a strong statistically significant difference ($p<0.0001$). Comparing both groups, the results are not statistically

significantly different ($p>0.05$). Oral symptoms improved by a mean difference of 1.56 ± 1.5 among the SDF group and 1.24 ± 1.52 among the ART group. ($P>0.05$). Functional limitations decreased by a mean difference of 1.4 ± 1.25 among the SDF group and 1.2 ± 1.56 among the ART group. ($P>0.05$). Emotional well-being improved by a mean difference of 0.24 ± 0.92 among the SDF group and 0.62 ± 1.29 among the ART group. ($P>0.05$). Social well-being, however, deteriorated by a mean difference of -0.04 ± 0.81 among the SDF group and -0.08 ± 0.6 among the ART group ($P>0.05$) (Table 3). Total FIS scores improved from a mean of 12.22 ± 2.52 pre-operatively to a mean of 10.38 ± 2.41 after twelve months for SDF group ($P<0.0001$) and from 11.1 ± 2.48 to 10 ± 2.52 for ART group ($P<0.0001$). Comparing the total scores of both groups, the results are not statistically significantly different ($P>0.05$). Parental/family activity improved from a mean score of 9.1 ± 2.28 at baseline to 7.5 ± 2.34 after twelve months among the SDF group and from 8.06 ± 2.53 to 6.96 ± 2.46 among the ART group. ($P<0.0001$). Parental emotions increased from a mean pre-operative score of 0.94 ± 0.42 to a mean score of 0.96 ± 0.67 after twelve months among the SDF group, and from 1 ± 0.57 to 1.08 ± 0.63 among the ART group ($P>0.05$). Family conflict decreased from a mean score of 2.18 ± 0.83 pre-operatively to a mean score of 1.92 ± 0.92 after twelve months among the SDF group ($P\leq0.05$), and from 2.04 ± 0.95 to 1.96 ± 0.9 among the ART group ($P>0.05$) (Table 3).

Discussion

The null hypothesis that stated that no differences will be

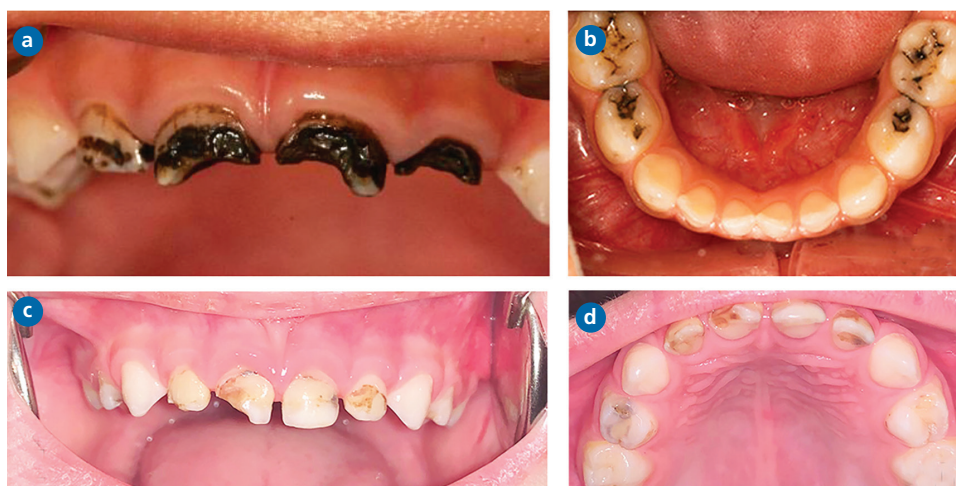


FIG. 2 Twelve months follow up after SDF and ART. (a) SDF: Caries arrest in anterior teeth (b) SDF: Caries arrest in posterior teeth (c) ART: Teeth considered failed because of marginal gaps > 0.5 mm – teeth were asymptomatic (d) ART: Note the arrested exposed dentin despite of failed restorations.

Variables			SDF (N=50 children, n=268 teeth)	ART (N=50 children, n=286 teeth)	P value
Demographic background	Age: Mean (SD)		2.98 (0.85)	3.08 (0.99)	0.61
	Gender: n (%)	Boys	21 (42%)	26 (52%)	0.32
		Girls	29 (58%)	24 (48%)	
	Mother education	Elementary or less	26 (52%)	22 (44%)	0.626
		Secondary	18 (36%)	21 (42%)	
Oral health related habits	Daily tooth brushing	Yes	9 (18%)	13 (26%)	0.344
		No	41 (82%)	37 (74%)	
	Frequency of snacks/day	<1	0 (0%)	0 (0%)	0.418
		1-2 times	23 (46%)	19 (38%)	
		3 or more	27 (54%)	31 (62%)	
Teeth	Teeth included/patient: Mean (SD)		5.36 (3.46)	5.72 (3.55)	0.587
	Type of teeth: n (%)	Anterior	141 (52.6%)	163 (57%)	0.30
		Posterior	127 (47.4%)	123 (43%)	
Caries experience	dmft: Mean (SD)		6.60 (3.57)	6.38 (3.86)	0.71

TABLE 1 Sample description.

detected between SDF and ART regarding their caries arresting potential and their impact on the OHRQoL was partially rejected. SDF was significantly superior to ART regarding caries arresting potential after 12 months, while the positive impact on the OHRQoL was comparable for both SDF and ART. Immediate intervention and temporarily restoring teeth in young children with ECC until traditional restorative measures become possible has been recommended [Colak et al., 2016]. Since all participants had active carious lesions, it was decided that for every patient, all eligible teeth were treated in a single visit at baseline. This did not only help prevent further progression of the decay, but also provided an accurate vision about the influence of the intervention provided on the OHRQoL.

Since neither SDF nor ART are valid for treating pulpally involved teeth, those teeth with any clinical or radiographic signs of pulpal involvement were excluded from the sample [Crystal and Niederman, 2019].

The terms 'success' and 'failure' were used to represent caries 'arrest' and 'progression' in both groups, respectively. Among the SDF group, this was done based on color and texture of lesions [Miller, 1959]. For the ART group, since the lesions were restored with glass ionomer and were no longer visualised, another method was necessary to judge caries arrest or

progression. As stated by Kidd [2010], a cavity that is well-sealed by a restoration represents an arrested, inactive lesion. Based on this, the "ART Evaluation Criteria" were used to evaluate the clinical performance of restorations [Phantumvanit et al., 1996].

Regarding the SDF group in the present trial, high success rates were reported, which is in accordance to previously reported findings [Llodra et al., 2005; Yang Q, 2002; Ye, 1995; Zhi et al., 2012]. Conversely, Mabangkhu et al. [2002] reported much lower caries arrest rates (35.7%) and they associated this to the very young age of participants aging 1–3 years old, whose majority were still nursing, and to the difficulty in maintaining proper oral hygiene as well as difficulty in applying SDF [Mabangkhu et al., 2020].

It is well known to paediatric dentists that successfully management of carious anterior primary teeth is challenging. The present study did not aim to verify nor doubt this, but instead, it aimed to manage ECC under real life conditions that almost always involve anterior teeth and where more ideal options such as full coverage may not be convenient. For this reason, no restrictions were made regarding the type of tooth, size of lesion, multiple surface and/or incisal edge involvement. The success of SDF in this trial was not compromised in anterior teeth which was also observed in previous trials [Fung et al., 2018; Mabangkhu et al., 2020; Zhi et al., 2012]. Duangthip et al. [2016] explained such observation by that plaque control is easier in the anterior region. Whereas, Crystal and Niederman [2016] referred it to the exposure of anterior teeth to more light owing to their position in the oral cavity resulting in more precipitation of active silver. They even suggested including a few seconds of light curing in the application protocol.

As regards the ART group, short-term success that dropped gradually over time was reported and was consistent with Dos Santos et al. [2012] who reported 38.6% success of ART after twelve months. Several studies, however, have reported success rates higher than the current trial [Arrow and Forrest, 2020; Faustino-Silva and Figueiredo, 2019]. Those trials did not include anterior teeth and had limited their samples to average sized lesions. Furthermore, among the reasons of low success rates of ART in our trial, the ART evaluation criteria employed are known to be inflexible, where any marginal defect greater than 0.5 mm was counted as failure, even if the restoration was present. It was noted that most of the ART restorations that were counted as failures, were surviving and were asymptomatic.

In the current study, SDF group had consistently and significantly shown more success than the ART group at all recall points. This agreed with the findings of previous studies [Dos Santos et al.,

Follow up	SDF (n=268 teeth)		P value	ART (n=286 teeth)		P value
	Anterior teeth (n=141)	Posterior teeth (n=127)		Anterior teeth (n=163)	Posterior teeth (n=123)	
	n (%)			n (%)		
3 months	137 (97.2%)	122 (96.1%)	0.740	142 (87.1%)	116 (94.3%)	0.161
	259 (96.6%)			258 (90.2%)		
	p = 0.008*					
6 months	135 (95.7%)	119 (93.7%)	0.453	111 (68.1%)	112 (91.1%)	<0.0001*
	254 (94.8%)			223 (78%)		
	p<0.0001*					
9 months	135 (95.7%)	118 (92.9%)	0.314	76 (46.6%)	99 (80.5%)	<0.0001*
	253 (94.4%)			175 (61.2%)		
	p<0.0001*					
12 months	135 (95.7%)	118 (92.9%)	0.314	46 (28.2%)	52 (42.3%)	0.042*
	253 (94.4%)			98 (34.3%)		
	p<0.0001*					

*Statistically significant difference at p value≤0.05

TABLE 2 Comparison of success rates (caries arrest) between SDF and ART groups at 3M, 6M, 9M, and 12M follow up time points.

Domains		SDF		ART		P value
		(n=50 children)		(n=50 children)		
Mean (SD)						
P-CPQ Domains	Oral symptoms	Before	3.18 (1.81)	3.10 (2.12)	0.65	
		After	1.62 (0.83)	1.86 (1.07)	0.41	
		P value	<0.0001*	<0.0001*		
	Functional limitations	Before	2.26 (1.93)	1.80 (2.03)	0.15	
		After	0.86 (1.07)	0.60 (0.86)	0.21	
		P value	<0.0001*	<0.0001*		
	Emotional well-being	Before	4.86 (1.84)	4.64 (1.87)	0.49	
		After	4.62 (1.68)	4.02 (1.74)	0.06	
		P value	0.06	0.002*		
	Social well-being	Before	0.46 (1.13)	0.62 (1.38)	0.72	
		After	0.50 (1.04)	0.70 (1.16)	0.29	
		P value	0.65	0.33		
	Total score	Before	10.76 (3.43)	10.16 (3.62)	0.50	
		After	7.60 (2.42)	7.18 (2.27)	0.30	
		P value	<0.0001*	<0.0001*		
FIS Domains	Parental/family activity	Before	9.10 (2.28)	8.06 (2.53)	0.06	
		After	7.50 (2.34)	6.96 (2.46)	0.26	
		P value	<0.0001*	<0.0001*		
	Parental emotions	Before	0.94 (0.42)	1.00 (0.57)	0.67	
		After	0.96 (0.67)	1.08 (0.63)	0.32	
		P value	0.81	0.31		
	Family conflict	Before	2.18 (0.83)	2.04 (0.95)	0.45	
		After	1.92 (0.92)	1.96 (0.90)	0.51	
		P value	0.02*	0.45		
	Total score	Before	12.22 (2.52)	11.10 (2.48)	0.24	
		After	10.38 (2.41)	10.00 (2.52)	0.33	
		P value	<0.0001*	<0.0001*		

*Statistically significant difference at p value≤0.05

TABLE 3 Comparison of responses to P-CPQ and FIS questionnaire pre-operatively and after twelve months.

2012, Zhi et al., 2012, Satyarup et al., 2022]. Vollu et al. [2019] reported comparable success among SDF and ART, nevertheless, they still recommended the use of SDF as a more practical option than ART to manage ECC owing to its easier technique and lower cost.

A successful treatment from a clinical standpoint is not necessarily satisfactory from the patients' perspective. In addition to health improvement, patients have other goals, expectations, and priorities. This highlights the worth of patient reported outcomes regarding any intervention, so as to weigh the real value of this intervention. In the current study, an overall significant positive impact on the OHRQoL was reported for both groups with SDF being slightly superior to ART which is consistent with previous studies [Vollu et al., 2019; Rodrigues et al., 2020]. Improvement in emotional well-being was only significant for the ART group, perhaps due to the better aesthetics. Family conflict improvement was only significant in the SDF group, probably because parents had witnessed the ease of SDF application together with the absence of complaints afterwards. Nevertheless, social well-being and parental emotions slightly worsened in both groups. Likewise, Vollu et al. [2019] that reported that unlike all other domains, family function improvement was not significant neither after SDF nor ART.

Previous studies that were carried out in kindergartens, did not report significant changes in OHRQoL after SDF or ART. Those children did not seek treatment in the first place, meaning that their OHRQoL was not originally compromised and thus there was no sufficient opportunity for improvement [Duangthip et al., 2019, Jiang et al., 2019].

Temporary staining of the gingiva and/or skin after accidental contact with SDF occurred twice in this study. Otherwise, no adverse effects were reported among both groups. The sample in this study was a convenient sample, therefore, the results provide evidence for this population only and cannot be generalised to the Egyptian population.

Conclusion

- Biannual application of 38 % SDF was significantly more effective in arresting ECC after 12 months compared to ART.
- An overall significant positive impact on the oral health related quality of life was reported for both groups with SDF being slightly superior to ART.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

The authors wish to thank Prof. Maha Tantawy and D. Hams Hamed for their contribution in the statistical analysis.

REFERENCES

- Administration FaD. Diammine silver fluoride dental hypersensitivity varnish. 510[k] premarket notification; 2017. Available at: <http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfpmn/pmn.cfm?id=k102.973>. Accessed 2018 dec 20.
- Al-Riyami I, Thomson W, Al-Harhi L 2016. Testing the arabic short form versions of the parental-caregivers perceptions questionnaire and the family impact scale in oman. *Saudi Dent J*, 28, 31-35.
- Arrow P, Forrest H 2020. Atraumatic restorative treatments reduce the need for dental general anaesthesia: A non-inferiority randomized, controlled trial. *Aust Dent J*, 65, 158-67.
- Colak H, Dülgergil C, Dalli M 2016. American academy of pediatric dentistry. Policy on early childhood caries [ecc]: Classifications, consequences, and preventive strategies. *Pediatr Dent*, 30, 40-3.
- Crystal YO, Niederman R 2016. Silver diamine fluoride treatment considerations in children's caries management. *Pediatr Dent*, 38, 466-471.
- Crystal YO, Niederman R 2019. Evidence-based dentistry update on silver diamine fluoride. *Dent Clin North Am*, 63, 45-68.
- Dikmen B 2015. Icdas ii criteria [international caries detection and assessment system]. *J Istanb Univ Fac Dent*, 49, 63-72.
- Dos Santos VE, Jr., De Vasconcelos FM, Ribeiro AG, Rosenblatt A 2012. Paradigm shift in the effective treatment of caries in schoolchildren at risk. *Int Dent J*, 62, 47-51.
- Duangthip D, Chu CH, Lo EC 2016. A randomized clinical trial on arresting dentine caries in preschool children by topical fluorides--18 month results. *J Dent*, 44, 57-63.
- Duangthip D, Gao SS, Chen KJ, Lo ECM, Chu CH 2019. Oral health-related quality of life of preschool children receiving silver diamine fluoride therapy: A prospective 6-month study. *J Dent*, 81, 27-32.
- Elghandour RK, Eltekeya MM, Sharaf AA 2021. Parental satisfaction after using silver diamine fluoride on their children's primary teeth: A randomized clinical trial. *Alex Dent J*, 46, 157-162.
- Faustino-Silva DD, Figueiredo MC 2019. Atraumatic restorative treatment-art in early childhood caries in babies: 4 years of randomized clinical trial. *Clin Oral Investig*, 23, 3721-3729.
- Frencken JE, Leal SC, Navarro MF 2012. Twenty-five-year atraumatic restorative treatment (ART) approach: A comprehensive overview. *Clin Oral Investig*, 16, 1337-46.
- Fung M, Duangthip D, Wong M, Lo E, Chu C 2018. Randomized clinical trial of 12% and 38% silver diamine fluoride treatment. *J Dent Res*, 97, 171-178.
- Hiraishi N, Sayed M, Takahashi M, Nikaido T, Tagami J. Clinical and primary evidence of silver diamine fluoride on root caries management. *Jpn Dent Sci Rev* 2022; 58, 1-8.
- Ismail AI, Sohn W, Tellez M, Amaya A, Sen A, Hasson H, Pitts NB 2007. The international caries detection and assessment system [ICDAS]: An integrated system for measuring dental caries. *Community Dent Oral Epidemiol*, 35, 170-8.
- Jiang M, Wong MCM, Chu CH, Dai L, Lo ECM 2019. Effects of restoring sdf-treated and untreated dentine caries lesions on parental satisfaction and oral health related quality of life of preschool children. *J Dent*, 88, 103171.
- Kidd EA 2010. Clinical threshold for carious tissue removal. *Dent Clin*, 54, 541-549.
- Llodra JC, Rodriguez A, Ferrer B, Menardia V, Ramos T, Morato M 2005. Efficacy of silver diamine fluoride for caries reduction in primary teeth and first permanent molars of schoolchildren: 36-month clinical trial. *J Dent Res*, 84, 721-4.
- Mabangkhu S, Duangthip D, Chu CH, Phonghanyudh A, Jirattanasopha V 2020. A randomized clinical trial to arrest dentin caries in young children using silver diamine fluoride. *J Dent*, 103375.
- Miller WA. 1959. Layering the dentin caries as demonstrated by localization by dyes. University of Illinois Chicago Professional Colleges.
- Phantumvanit P, Songpaisan Y, Pilot T, Frencken JE 1996. Atraumatic restorative treatment (ART): A three-year community field trial in thailand--survival of one-surface restorations in the permanent dentition. *J Public Health Dent*, 56, 141-5; discussion 161-3.
- Rodrigues GF, Costa TDC, Massa GDS, Vollu AL, Barja-Fidalgo F, Fonseca-Gonçalves A 2020. Oral health-related quality of life in preschool children after silver diamine fluoride versus atraumatic restorative treatments. *Pediatr Dent*, 42, 373-379.
- Satyarup D, Mohanty S, Nagarajappa R, Mahapatra I, Dalai RP. Comparison of the effectiveness of 38% silver diamine fluoride and atraumatic restorative treatment for treating dental caries in a school setting: A randomized clinical trial. *Dent Med Probl* 2022; 59, 217-223.
- Thomson WM, Foster Page LA, Gaynor WN, Malden PE 2013. Short-form versions of the parental-caregivers perceptions questionnaire and the family impact scale. *Community Dent Oral Epidemiol*, 41, 441-50.
- Vollu AL, Rodrigues GF, Rougemont Teixeira RV, Cruz LR, Dos Santos Massa G, De Lima Moreira JP, Luiz RR, Barja-Fidalgo F, Fonseca-Gonçalves A 2019. Efficacy of 30% silver diamine fluoride compared to atraumatic restorative treatment on dentine caries arrestment in primary molars of preschool children: A 12-months parallel randomized controlled clinical trial. *J Dent*, 88, 103165.
- Yamaga R, Yokomizo I 1969. Arrestment of caries of deciduous teeth with diamine silver fluoride. *Dent Outlook*, 33, 1007-1013.
- Yang Q WB, Ye Z 2002. Clinical effectiveness of using silver diamine fluoride to treat caries on primary anterior teeth. *Heilongjiang Med Pharmacol*, 3, 66-7.
- Ye Z 1995. The use of 38% silver diamine fluoride in dental caries. *Chin. J. Conserv*, 1, 32.
- Zhi QH, Lo EC, Lin HC 2012. Randomized clinical trial on effectiveness of silver diamine fluoride and glass ionomer in arresting dentine caries in preschool children. *J Dent*, 40, 962-7.