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ORIGINAL RESEARCH

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Can silver diamine fluoride reduce invasive treatments with general anesthesia?

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Abstract

This study aims to retrospectively evaluate the differences in dental treatments rendered in general anesthesia (GA) for patients who did or did not receive application of silver diamine fluoride (SDF) prior to GA. 1559 patients (≤6 years) who completed treatment with GA for caries at University of California San Francisco (UCSF) between 2015 and 2019 were included in the study. At baseline patients' electronic health record was reviewed to collect planned treatment, complete dental treatment and demographics. Patients were identified as SDF group (N = 335, 21.49%) or comparison (N = 1224, 78.51%). Dental treatments rendered were compared between the SDF and comparison group with multi-variable regression, including variables for demographics and clinical findings at baseline. The initial analysis identified variations in gender, age, dental pain, pulp involvement, and initial treatment plans between the SDF and comparison groups at baseline. In an unadjusted analysis, the SDF group displayed a statistically significant increase in the number of crown procedures but a notable decrease in the number of pulp therapy and extraction treatments completed ($p < 0.05$). An adjusted multivariable model affirmed the inverse relationship between SDF application and completion of pulp therapy and extractions at the time of GA ($p < 0.05$). No significant association was identified with the total number of crowns needed and SDF. The model further indicated a positive correlation between the total count of pulp therapy and extractions completed with patient age and the wait-time for GA. In conclusion, pre-GA application of SDF to carious primary teeth is negatively correlated with completed pulp therapy and extraction. SDF application prior to dental treatment with GA may be a valuable tool to reduce invasive dental procedures in GA.

Keywords

Silver diamine fluoride; Caries; General anesthesia; Early childhood caries; Hospital dentistry

1. Introduction

According to the Centers for Disease Control and Prevention (CDC) data from 2015–2016, the prevalence of caries and untreated caries among individuals aged 2–19 years in the United States was 46% and 13%, respectively [1]. Additionally, there was an inverse correlation observed between caries prevalence and household income, indicating that those from low-income households experienced higher of dental caries and also more likely to have untreated caries. Barriers to accessing dental care may encompass factors such as the availability of providers locally, cost, transportation and health literacy [2].

Often, children with extensive dental disease at a young are, or those with complex medical conditions will require advanced behavior management techniques, including the use of general anesthesia (GA), to undergo restorative and surgical dental procedures [3]. In California, approximately 133,000 patients under 21 years of age have sedation or general anesthesia for dental treatment annually [4]. Even in cases of extensive dental decay and an urgent need for treatment, there can be prolonged waiting times for dental care requiring GA. In one study conducted at the University of Washington, the average wait-time for dental care with GA was 28 days for children experiencing pain and about 71 days for those not experiencing pain [5, 6]. At the University of California, San Francisco (UCSF) the estimated wait time to GA is about sixty to ninety days. As a result of extended waiting periods between consultation and treatment, coupled with the progressive nature of dental caries, children awaiting procedures involving GA face an elevated risk of experiencing painful dental episodes, developing dental abscesses, and requiring dental extractions either before or on the scheduled treatment date [6].

Silver Diamine Fluoride (SDF) is a liquid medicament used topically that consists of silver, ammonium, and fluoride ions. In a systematic review conducted by Gao *et al.* [7], it was determined that a 38% SDF solution exhibited the highest efficacy for caries treatment in primary teeth, halting the progression

of caries in 81% of the treated sites. Application of SDF is relatively simple and not overly reliant on precise technique. It can be administered to children with special healthcare needs or challenging behavior without the necessity of local anesthesia or advanced behavior management techniques [8]. Therefore, the use of 38% SDF to arrest caries progression can be particularly applicable for children who are waiting to receive dental care in GA [9]. At present, there is a scarcity of published research that examines the immediate impact of SDF application on the dental treatment requirements of children awaiting GA.

The main aim of this retrospective cohort study was to assess the effects of applying SDF to decayed primary teeth in children prior to comprehensive dental treatment with GA. Specifically, the study aimed to examine how SDF application was related to subsequent dental procedures performed during GA. The hypothesis under investigation is that patients who received SDF prior to GA would have reduced number of invasive dental treatments, such as pulp therapy or extractions.

2. Methods

2.1 Study design

A retrospective chart review was conducted for patients from the UCSF Pediatric Dentistry division who received dental treatment with GA between January 2015 and June 2019.

2.2 Study population

The study enrolled patients from the UCSF Division of Pediatric Dentistry who met the following inclusion criteria: (1) Children aged 6 years or younger at the time of the GA procedure; (2) Classified as American Society of Anesthesiologists (ASA) Physical Status Classification System I or II; (3) Referred for GA between January 2015 and January 2019; and (4) Completed their dental treatment under GA at UCSF Benioff Children's Hospital San Francisco between January 2015 and June 2019. Exclusion criteria included: (1) children with ASA 3 or above, or who had a known sensitivity to silver or nickel. All eligible subjects were divided into two groups based on whether they received SDF prior to their GA appointment (SDF intervention group) or not (Comparison group).

2.3 Data Collection

All patients charts were reviewed by four calibrated investigators. Investigators reviewed for inclusion and exclusion criteria and extracted study data from the Electronic Health Record (EHR). Calibration of the investigators were performed on 20 patient charts after training until 90% agreement was met (Cohen's kappa score 0.9 or higher). Five percent of the records underwent a random review to assess data accuracy and to perform cross- and self-calibration. No identifiable data were gathered from the EHR; as a result, patient consent was not required by the IRB for this retrospective study.

Patient's demographics and child's special health care need (SHCN) status were collected. SHCN was a dichotomous variable assigned to each patient based on if they fit the American Academy of Pediatric Dentistry (AAPD) definition of SHCN [10].

The baseline pre-GA treatment data collected included: GA referral date, age at the time of GA referral, number of SDF applications child had received, dates of SDF application(s), reported dental pain, pulpal involvement or dental infection (including evident fistula or abscess, or periapical radiolucency), and the patient's dmft status at the time of GA referral.

The dental treatment plan generated at the time of consult at UCSF prior to GA and final treatment rendered in GA were reviewed and data was extracted, including the aggregate number of crowns, intra-coronal fillings, pulp therapy (pulpotomy and pulpectomy) and extractions for each patient. Data were aggregated by treatment type in total for each patient. Invasive dental treatments were defined as extractions and pulpal treatments.

Treatment plans for GA were generated by UCSF Pediatric Dentistry providers at the time of referral to GA based on findings at the consultation visit at the UCSF dental clinics. Treatment plans were generated by pediatric dentistry faculty who provide care in the OR, or by pediatric dental residents with review and approval by faculty who provide care in the OR. The standard at UCSF pediatric dentistry is that patients are scheduled in the OR with the same faculty provider who generated or approved the consultation treatment plan and referral to GA.

Investigators created set of data variables described as "unplanned treatment". Unplanned treatment was defined as the total of treatment type completed in GA, less the number treatment type planned at consult (*i.e.*, # teeth extracted in GA − # teeth planned for extraction at consult = # unplanned extraction). These data variables indicate how treatment rendered differed from the treatment planned at referral to GA. This represents a rough assessment of disease advancement, as an increased number of completed crowns or extractions compared to the initial plan would suggest that caries have advanced during the period between consultation and treatment. Fewer unplanned treatments would indicate that treatment needs were less than anticipated at the consult visit. Zero unplanned treatments would indicate that the total treatment rendered in GA was equal to the treatment planned at time of consult.

Outcome variables of interest to be evaluated included planned treatment at consultation, completed treatment in GA, and unplanned treatment variables.

2.4 Data analysis

Descriptive statistics, including mean, standard deviation, frequency, and percentage, were employed to summarize continuous and categorical variables within the SDF and comparison groups. The normality assumption regarding variable distribution was assessed through histograms and the Shapiro-Wilk test [11]. To compare baseline variables, we utilized independent *t*-tests or Mann-Whitney U tests for continuous variables and Chi-Square tests for categorical variables. Analyses were conducted in STATA Version 17 (StataCorp LLC, College Station, TX, USA).

Independent *t* tests or Mann-Whitney U Test were used to

compare treatment outcome measures (number of dental treatments completed, number of unplanned treatments completed in GA) between the SDF and comparison groups, depending on if a treatment outcome measure is approximately normally distributed. Poisson, negative binomial, and linear multi-variable regressions, depending on the outcome distribution, were used to assess the group differences in treatment outcome measures while including unbalanced baseline variables. The effects of baseline and demographic variables were also assessed in the multi-variable models on the outcomes of completed and unplanned treatment.

3. Results

3.1 Baseline data and study population demographics

The study included a total of 1559 children. Among them, 21.49% (N = 335) received SDF, while 78.51% (N = 1224) did not receive SDF prior to GA. Table 1 presents the baseline data. None of the baseline variables displayed a normal distribution, as confirmed by the Shapiro-Wilk Test.

The SDF group had a greater proportion of females and individuals of younger age at the time of GA treatment, with a mean age difference of 4.4 months. Additionally, those who had received SDF were more likely to have special healthcare needs and displayed evident signs of pulpal involvement ($p < 0.05$). However, there were no statistically significant differences in the number of children experiencing dental pain, the time between consultation and GA treatment, or the dmft scores between the SDF and comparison groups ($p > 0.05$).

The majority of children who received SDF received one application (81.1%) (mean number of applications 1.3 ± 0.03). Use of SDF increased over the study period, with about 4% of patients treated in GA in 2015 having received SDF, compared with 8% in 2016, 20% in 2017, 31% in 2018 and 34% in 2019.

The treatment plans for the SDF group exhibited statistically significant differences, as shown in Table 1. Specifically, the SDF group demonstrated a significantly higher incidence of planned crowns ($p < 0.001$) and pulp treatments ($p = 0.001$), while also having a lower frequency of planned intra-coronal fillings. To address the potential differences in treatment related to teeth nearing natural exfoliation, we conducted a comparison of the number of anterior teeth planned for extraction between children aged over 60 months and those aged 60 months or younger. This analysis did not uncover any statistically significant variation in the average number of anterior teeth scheduled for extraction between these two age groups ($p = 0.298$).

3.2 Outcome data

Table 1 presents the average number of dental treatments completed in the study population, classified by SDF intervention group and comparison group. The SDF intervention group exhibited a higher count of crowns ($p < 0.01$), whereas there was a significant reduction in the number of pulp therapy procedures ($p = 0.01$) and extractions completed ($p < 0.01$).

Figs. 1,2 depict box plots illustrating the comparison of completed and unplanned crowns, pulp therapy, intra-coronal fillings, and extractions between the SDF and comparison groups. Notably, the SDF intervention group exhibited significantly lower rates of unplanned extractions ($p < 0.01$) and unplanned pulp therapy ($p < 0.01$).

In order to account for the influence of uneven baseline disease, treatment plan and demographic variables between the two groups, a multivariable regression model was used to examine the impact of SDF on treatment completed while controlling for these uneven variables (Table 2).

In the regression model, SDF did not have a significant correlation with completed crowns ($p = 0.222$) or intra-coronal fillings ($p = 0.103$). However, the regression model found a statistically significant negative relationship between SDF and completed pulp therapy ($p < 0.001$) and extractions ($p = 0.006$).

The study data indicated an average waiting period of 131 days from consultation to GA treatment. Notably, a positive correlation was observed between the wait-time and the number of completed pulpal therapy ($p = 0.004$) and extractions ($p = 0.004$).

In addition, the model revealed a positive association between the completion of extractions and special healthcare needs (SHCN) ($p = 0.002$), age at general anesthesia (GA) ($p < 0.001$), dental pain ($p = 0.041$), as well as the planned total number of extractions ($p < 0.001$).

In the analysis presented in Table 3, concerning completed unplanned treatments, there was no observed relationship between SDF and the completion of unplanned crowns. However, the model did reveal a statistically significant negative association between SDF and both unplanned pulp therapy and unplanned extractions ($p < 0.001$ and $p = 0.008$, respectively). Furthermore, the wait time to GA treatment exhibited a positive correlation with unplanned pulp therapy ($p < 0.001$). Additionally, unplanned extractions were positively associated with the presence of SHCN ($p < 0.001$), the age at GA treatment ($p < 0.001$), the presence of dental pain ($p = 0.044$), planned pulp therapy ($p = 0.005$), and the wait time for GA treatment ($p < 0.001$).

4. Discussion

This study indicates that application of SDF prior to GA for children 6 years old and younger had an inverse relationship with the number of completed invasive and unplanned dental treatments in GA (*i.e.*, pulp therapy and extractions). The hypothesis that SDF application is correlated with fewer invasive dental treatments was accepted by this study. Although there are no other studies examining the effects of SDF prior to GA for direct comparison, the findings of this study is in agreement with other published studies that demonstrate SDF can arrest caries progression [12, 13]. In a non-GA study population, SDF has been shown to reduce the need for restorative treatment in children [14]. SDF treatment is recommended when it is not possible to promptly complete treatment for a primary tooth. Furthermore, use of SDF increased over the study period which can likely be attributed to increased research and publications on the efficacy of SDF, and poignantly the publication of the AAPD guidelines on SDF being published in 2017.

TABLE 1. Patient demographic and baseline disease and dental treatments planned and completed.

	Comparison group		Silver diamine fluoride group		All		p value[†]
Baseline data							
Sample size (N)	1224 (79%)		335 (21%)		1559		
Female (%)	41%		50%		43%		**0.003**
Patients with special health care needs (Yes %)	29%		22%		28%		**0.01**
Dental pain before GA (Yes %)	17%		19%		18%		0.57
Had teeth with obvious pulpal involvement (Yes %)	36%		41%		36%		**0.03**
	Mean ± SE	Median	Mean ± SE	Median	Mean ± SE	Median	p value[†]
Time to general Anesthesia (d)	131.2 ± 3.1	104	131.0 ± 6.6	104	131.1 ± 2.8	104	0.79
Age at general Anesthesia (mon)	55.7 ± 0.4	55	51.3 ± 0.8	50	54.8 ± 0.4	54	<**0.001**
Baseline dmft	10.9 ± 0.1	11	11.2 ± 0.2	12	11.0 ± 0.1	11	0.06
Planned treatment at referral (# of Teeth)							
Total crowns	7.2 ± 0.1	7	8.4 ± 0.2	8	7.4 ± 0.1	8	<**0.001**
Total intra-coronal fillings	1.8 ± 0.1	0	1.2 ± 0.1	0	1.7 ± 0.1	0	<**0.001**
Total pulp therapy	0.4 ± 0.04	0	0.6 ± 0.08	0	0.5 ± 0.04	0	**0.001**
Total extraction	1.0 ± 0.0	0	0.8 ± 0.1	0	0.9 ± 0.0	0	0.72
Completed treatment in general Anesthesia (#s of Teeth)							
	Mean ± SE	Median	Mean ± SE	Median	Mean ± SE	Median	p value[†]
	Control group		SDF Group		All		
Total teeth extracted or restored due to caries	12.4 ± 0.1	12	12.9 ± 0.2	13	12.5 ± 0.1	12	**0.01**
Completed total crowns	8.09 ± 0.1	8	8.96 ± 0.0	8	8.3 ± 0.1	8	**0.002**
Completed total intra-coroconal fillings	2.05 ± 0.1	1	1.89 ± 0.1	1	2.0 ± 0.1	1	0.45
Completed total pulp therapy	1.28 ± 0.1	1	0.94 ± 0.1	0	1.2 ± 0.0	1	**0.01**
Completed total extraction	2.0 ± 0.1	1	1.3 ± 0.1	0	1.8 ± 0.1	1	<**0.001**
Completed treatment in general Anesthesia (#s of Teeth)							
	Mean ± SE	Median	Mean ± SE	Median	Mean ± SE	Median	p value[†]
	Control group		SDF Group		All		
Crowns completed unplanned	0.51 ± 0.1	0	0.59 ± 0.3	0	0.53 ± 0.11	0	0.75
Intra-coronal fillings completed unplanned	0.25 ± 0.1	0	0.67 ± 0.1	0	0.34 ± 0.07	0	**0.02**
Pulp completed unplanned	0.85 ± 0.1	0	0.34 ± 0.1	0	0.74 ± 0.05	0	**0.001**
Extraction completed unplanned	1.1 ± 0.1	0	0.65 ± 0.1	0	1 ± 0.06	0	<**0.001**

[†]*Statistical tests for median differences in continuous variables were conducted using Mann-Whitney U non-parametric test due to the data being non-normally distributed. Chi-squared tests were used to compare data for dichotomous variables. Bolded numbers indicate a statistically significant difference at a p value < 0.05.*

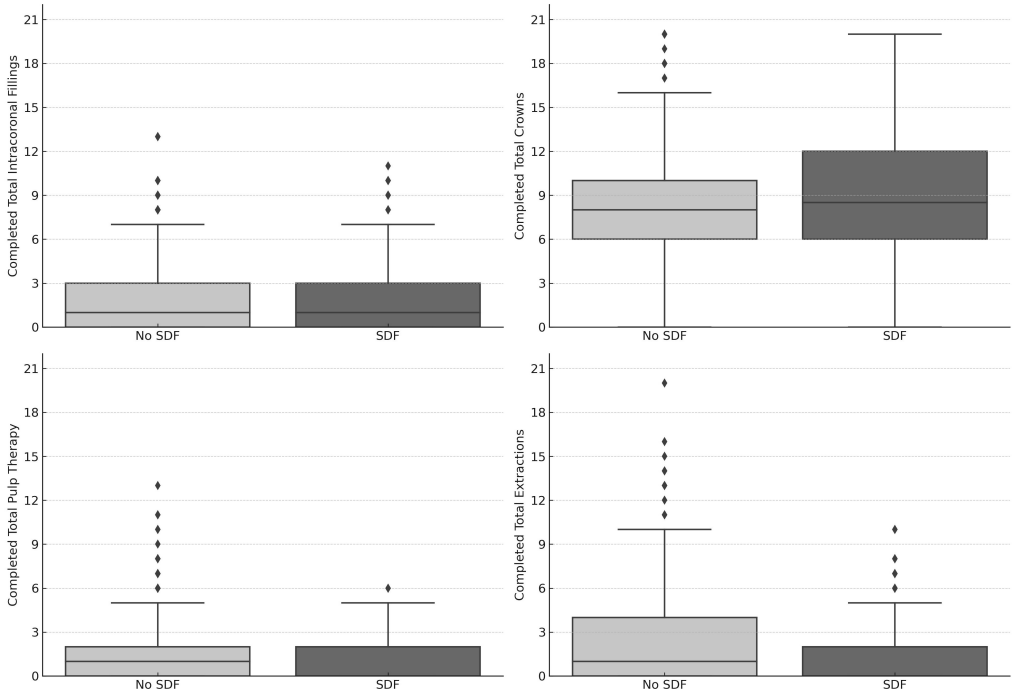

FIGURE 1. Total Completed Treatments by SDF and non-SDF Group. Box plot of total completed intracoronal restorations, crowns, pulp treatment and extractions with median (solid line) and mean (dashed line). The SDF treatment group received a higher number of crowns ($p < 0.01$), pulp therapy ($p = 0.01$), and extractions ($p < 0.01$). SDF: silver diamine fluoride.

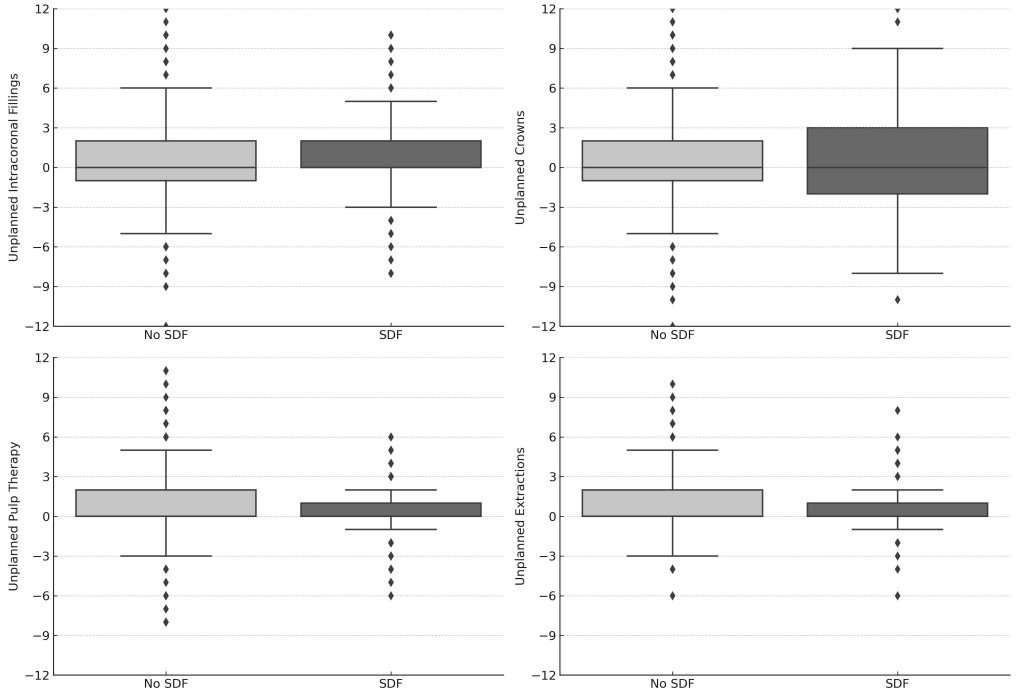

FIGURE 2. Unplanned Treatments Completed by SDF and non-SDF Group. Box plot of total unplanned intracoronal restorations, crowns, pulp treatment and extractions completed with median (solid line) and mean (dashed line). Values above zero indicate more of a treatment type completed than in the treatment plan at time of referral to GA, values below zero indicate fewer treatment types completed than was planned at referral to GA. The SDF treatment group received a higher number of intracoronal fillings ($p = 0.02$), pulp therapy ($p < 0.01$) and extractions ($p < 0.01$). SDF: silver diamine fluoride.

TABLE 2. Regression model for outcomes of completed crowns, intra-coronal fillings, pulp therapy and extractions.

Outcome variable	Crowns completed			Intra-coronal fillings completed			Pulp therapy completed			Extractions completed		
	Poisson Regression Model			Negative Binomial Regression			Negative Binomial Regression			Negative Binomial Regression		
Parameter	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value
SDF	0.03	0.26	0.22	0.16	0.10	0.10	−0.40	0.11	<0.001	−0.25	0.09	0.01
Gender	0.03	0.02	0.12	−0.07	0.08	0.37	0.00	0.08	0.97	−0.13	0.07	0.06
SHCN	−0.40	0.02	0.10	0.00	0.89	0.98	−0.23	0.09	0.01	0.23	0.08	0.002
Age at GA	0.00	0.00	<0.001	−0.01	0.00	<0.001	−0.01	0.00	0.09	0.01	0.00	<0.001
Pain	−0.05	0.03	0.07	−0.11	0.11	0.30	0.12	0.11	0.28	0.18	0.09	0.04
dmft Pre-GA	0.03	0.01	<0.001	−0.03	0.03	0.28	0.05	0.02	0.06	0.04	0.02	0.05
Planned crowns	0.04	0.01	<0.001	−0.01	0.25	0.68	0.03	0.02	0.25	0.01	0.02	0.57
Planned Intra-Coronal Fillings	0.00	0.01	0.64	0.15	0.03	<0.001	−0.06	0.03	0.04	−0.04	0.02	0.08
Planned Extractions	−0.02	0.01	0.01	−0.07	0.03	0.04	−0.02	0.03	0.44	0.23	0.03	<0.001
Planned pulp therapy	0.00	0.01	0.60	−0.04	0.03	0.15	0.10	0.03	<0.001	0.04	0.02	0.06
GA wait time	0.00	0.00	0.20	0.00	0.00	0.53	0.00	0.00	0.004	0.00	0.00	0.004
Constant/Intercept	1.67	0.06	<0.001	1.43	0.20	<0.001	−0.24	0.21	0.26	−1.12	0.18	<0.001

SDF: silver diamine fluoride; SHCN: special health care need; GA: general anesthesia; S.E.: Standard of error.

TABLE 3. Linear regression model for outcome of unplanned crowns, intra-coronal fillings, pulp therapy, and extractions.

	Crowns unplanned			Intra-coronal fillings unplanned			Pulp therapy unplanned			Extractions unplanned		
Parameter	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value	Coefficient	S.E.	*p* Value
SDF	0.27	0.22	0.23	0.20	0.17	0.24	−0.52	0.13	<0.001	−0.36	0.13	0.01
Gender	0.29	0.18	0.11	−0.07	0.14	0.63	0.02	0.10	0.87	−0.23	0.11	0.04
SHCN	−0.31	0.20	0.12	0.06	0.15	0.71	−0.25	0.11	0.03	0.49	0.12	<0.001
Age at GA	−0.04	0.01	<0.001	−0.02	0.00	<0.001	0.00	0.00	0.17	0.02	0.00	<0.001
Pain	−0.39	0.24	0.10	−0.31	0.18	0.09	0.17	0.14	0.21	0.29	0.14	0.04
Baseline dmft	0.23	0.05	<0.001	−0.04	0.04	0.27	0.05	0.03	0.10	0.06	0.03	0.06
Planned Crowns	−0.60	0.05	<0.001	−0.02	0.04	0.64	0.04	0.03	0.13	0.04	0.03	0.22
Planned intra-coronal fillings	0.05	0.06	0.45	−0.66	0.05	<0.001	−0.06	0.03	0.01	−0.04	0.04	0.28
Planned extractions	−0.18	0.07	0.01	−0.07	0.05	0.21	−0.03	0.04	0.48	−0.24	0.04	<0.001
Planned pulp therapy	−0.06	0.06	0.35	−0.05	0.07	0.31	−0.86	0.03	<0.001	0.10	0.04	0.01
GA wait time	0.00	0.00	0.20	0.00	0.00	0.87	0.00	0.00	<0.001	0.00	0.00	0.001
Constant/Intercept	4.56	0.46	<0.001	3.32	0.35	<0.001	0.65	0.26	0.01	−1.15	0.27	<0.001

SDF: silver diamine fluoride; SHCN: special health care need; GA: general anesthesia; S.E.: Standard of error.

Obtaining operating room access is becoming more and more challenging for dental providers [15]. Thus interim care, such as SDF, can be utilized to slow the progression and/or arrest dental caries, to later reduce the need for invasive dental procedures [16]. Financial and insurance-related considerations associated with GA frequently hinder and postpone children's access to timely dental care. Therefore, the findings of this study are relevant not only to pediatric dentists who face limitations or reductions in operating room availability but also to patients and families compelled to defer dental treatment under GA due to financial or third-party payer constraints [17].

Wait time to GA in this study is similar to other published studies [18]. Results of study also aligns with the results from a prior study demonstrating that wait-time length for dental treatment with GA can alter the treatment types rendered and increase the number of dental extractions completed [6]. The results support the use of SDF as an additional intervention that could be implemented during wait times to GA, as it may help slow or arrest caries progression.

While SDF holds promise as a beneficial treatment option for children awaiting GA, it is crucial to acknowledge that only about 20% of children in this study actually received SDF. One obstacle to SDF placement is the concern over its esthetic impact, which can result in the affected tooth structure appearing black or dark brown. While research has demonstrated parental acceptance of SDF's esthetics, it is important to recognize that the visual appearance of the treatment may be a contributing factor to why not all children in this study opted for SDF [19].

A significant constraint of this study pertained to its retrospective and observational design. Randomization and blinding of patient assignments to either the SDF application or comparison groups were not feasible, resulting in imbalances in sample size, baseline population demographics, disease status, and planned treatments between the two groups. To address this limitation, authors identified known confounding factors and used multi-variable statistical models to account for the measured differences between the two groups. Despite including these many variables in the model, SDF placement still remained correlated with treatment outcomes including SDF being negatively correlated with completion of pulp therapy and extractions. However, it is possible that there are additional variables that confound the results that were not accounted for in the model analyses. Additional prospective randomized studies investigating the impact of SDF on dental treatment outcomes are warranted.

Another limitation of this study is a lack of tooth level data analysis in this study. Thus, the planned and completed treatment for each tooth could not be tracked, but only in aggregate for each patient. The unplanned treatment variables—the sum of treatments completed in a patient less the number of treatments planned was used as a rough measure of caries progression; this represented a change in the total treatment deemed necessary by the provider from the consult to treatment date. This variable also helps to account for selection bias in application of SDF. Application of SDF was likely biased toward teeth that were expected to survive. Whereas teeth that appeared unrestorable and/or with abscess or fistula would likely not have received SDF. An increase in the number of teeth extracted, compared with the number of teeth planned for extraction would indicate that teeth that were expected to survive did not. In this study, unplanned extractions were reduced by the use of SDF and thus may indicate that SDF has the potential to lead to increased tooth survival in the time from consult to treatment with GA. However, a limitation of this measure is that not all children in this study would have been cooperative enough to complete radiographs prior to GA. As a result, some of the treatment plans for patients were based solely on visual examination and caries may have been underdiagnosed at time of referral.

This study was completed at a large academic medical center that included care provided by post graduate dental residents, and pediatric dental faculty. All treatment plans in this study were reviewed and revised by faculty and all residents are supervised closely in treatment planning for GA. While our institution aims for GA to be scheduled with the same faculty who planned or approved the treatment plan, this is occasionally not the case. It is imperative that further prospective randomized controlled studies be conducted to assess the impact of SDF application on primary teeth in children undergoing GA.

5. Conclusions

1. Applying SDF to carious primary teeth prior to GA is associated with fewer extractions and pulp treatments at time of GA.

2. General and pediatric dentists should consider application of SDF at time of referral to GA to potentially reduce the need for invasive dental treatments, especially when wait time to GA is long.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

JMS and LZ—initiated the study and were involved in its design and oversight. PL—collected data and contributed to the study design. KSH—provided study design advising and mentoring. JC and JMS—conducted the statistical analysis. All authors have contributed to writing of the manuscript and have read and approved the final manuscript for publication.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study underwent review and received approval from the Institutional Review Board (IRB #19-28346) at the University of California, San Francisco. The data analyzed was de-identified, and thus retrospective patient consent was not obtained.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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