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ORIGINAL RESEARCH

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Pediatric dental treatment under general anesthesia at a regional center on Jeju Island: a retrospective comparison of healthy patients and patients with special health care needs

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Abstract

Background: Pediatric patients with dental anxiety, behavioral difficulties, or special health care needs (SHCN) may require general anesthesia (GA), and Jeju Island's geographic isolation limits specialist access. We compared treatment patterns, perioperative outcomes, and preanesthetic evaluation between Healthy and SHCN patients, and whether differences persisted after case-mix adjustment. **Methods**: This retrospective study included all pediatric patients treated under GA at Jeju National University Hospital between January 2018 and June 2025. Costs are reported in Korean Won (KRW). Primary analyses used multivariable linear regression for log-transformed outcomes and logistic regression for incomplete evaluation, adjusted for age, sex, treatment category, and number of teeth treated; unadjusted comparisons were descriptive. **Results**: Of 402 GA sessions in 370 patients (median age, 6.0 years; 66.4% male), 235 (58.5%) involved SHCN patients. Operative time (118.0 in Healthy *vs.* 143.0 min in SHCN; $p = 0.012$), anesthesia time (153.0 *vs.* 185.0 min; $p = 0.001$), and cost (1,688,204 *vs.* 1,851,082 KRW; $p < 0.001$) were higher in SHCN sessions, but these differences were not evident after adjustment (−9.3%, $p = 0.065$; −4.9%, $p = 0.220$; +3.1%, $p = 0.440$). The induction and emergence interval remained 12.0% longer and incomplete preanesthetic evaluation more frequent (14.4% *vs.* 46.0%; adjusted odds ratio 4.20); both $p < 0.001$. Repeat GA was also more common in SHCN patients (0.6% *vs.* 14.2%; $p < 0.001$). Incomplete evaluation clustered in the two dental severe disability subgroups (52.1% and 48.8%) versus medical comorbidity alone (3.7%). Postoperative complications occurred in 0.5% of sessions. **Conclusions**: Pediatric dental GA at this center had a low complication rate. Longer unadjusted operative and anesthesia times and higher costs in SHCN patients were largely explained by the greater extent and composition of treatment. The SHCN-associated burden was more apparent in anesthetic transition time, incomplete preanesthetic evaluation, and repeat GA.

Keywords

General anesthesia; Pediatric dentistry; Special health care needs; Retrospective study; Jeju Island

1. Introduction

Dental caries remains one of the most prevalent chronic conditions in children worldwide [1], and effective behavior guidance is central to successful pediatric dental care. For most children, nonpharmacological approaches—including tell-show-do, positive reinforcement, and distraction—are sufficient to facilitate routine dental procedures [2]. However, these approaches may be inadequate for children with severe dental anxiety, developmental delay, autism spectrum disorder (ASD), intellectual disability, or other conditions that substantially impair cooperation [2, 3]. Such patients fall within the broader population of individuals with Special Health Care Needs (SHCN), whose medical, behavioral, cognitive, or physical conditions require modification of routine dental care [4]. For these patients, as well as for otherwise healthy children in whom conventional behavior guidance is unsuccessful, general anesthesia (GA) enables comprehensive dental treatment in a single session while minimizing psychological distress and eliminating the need for intraoperative cooperation [4, 5].

Over the past two decades, the use of GA for pediatric dental treatment has increased substantially worldwide [6–8]. Across diverse healthcare systems, tertiary dental in-

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stitutions have reported increasing pediatric GA utilization, attributed to factors such as greater caregiver awareness and expanded institutional capacity [7, 9, 10]. The proportion of GA cases involving patients with SHCN has also increased, reflecting greater recognition of their dental care needs [10–12]. Characterizing pediatric dental GA—including treatment scope, perioperative duration, and postoperative outcomes—is therefore increasingly important for both clinical practice and anesthetic practice settings worldwide.

Retrospective studies have characterized pediatric dental GA, and comparisons between SHCN and healthy patients have reported differences in treatment complexity, operative duration, and treatment cost [5, 9, 13–15]. Most of these comparisons, however, have been unadjusted despite systematic differences between groups in age, sex distribution, and treatment mix. Consequently, it remains unclear whether longer procedures and higher costs are independently associated with SHCN status or primarily reflect the type and extent of treatment delivered. The generalizability of these findings across different healthcare settings also remains uncertain.

Despite this growing literature, most studies have been conducted at large university-affiliated hospitals in major metropolitan areas [7, 13, 16, 17]. Geographically isolated populations—including residents of islands and regions with limited access to mainland medical infrastructure—face structural barriers to specialist dental care that are rarely represented in existing studies [18, 19]. Jeju Island, the largest island in the Republic of Korea, has a population of approximately 680,000 and exemplifies this challenge: its insular geography restricts access to mainland medical services, placing a unique burden on local institutions to provide comprehensive specialist care. Jeju National University Hospital is the only facility providing pediatric dental treatment under GA for this population and is also the government-designated regional oral health care center for persons with disabilities in the Jeju region [20]. Evidence from such regional settings is limited, despite its relevance to healthcare planning for geographically underserved populations.

Accordingly, this retrospective study aimed to describe the demographic and clinical characteristics of pediatric patients who underwent dental treatment under GA at the Department of Pediatric Dentistry, Jeju National University Hospital, between January 2018 and June 2025. The specific objectives were to (1) describe the demographic and clinical profile of pediatric dental GA practice on Jeju Island; (2) compare treatment patterns, preanesthetic evaluation completion, operative and anesthesia times, and total treatment costs between Healthy and SHCN patient groups; and (3) determine which between-group differences persisted after adjustment for age, sex, treatment category, and the extent of dental treatment delivered. The study was intended to provide evidence relevant to perioperative pathway design and regional resource planning for pediatric populations with limited access to specialist dental services.

2. Materials and methods

2.1 Study design and population

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Institutional Review Board of Jeju National University Hospital (IRB approval number: JEJUNUH 2025-06-007).

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines, and the patient selection process is summarized in Fig. 1. We retrospectively reviewed all pediatric patients who underwent dental treatment under GA at the Department of Pediatric Dentistry, Jeju National University Hospital, between January 2018 and June 2025. Of 378 patients initially identified, 8 were excluded because of incomplete or inaccurate medical records, leaving 370 patients who contributed 402 GA sessions. No formal a priori sample size calculation was performed because the study included all the complete eligible case series available during the 7.5-year study period.

2.2 Variables and data collection

Data were retrieved from electronic medical records (EMR), including preanesthetic evaluation forms, operative records, and patient demographic information. Recorded variables included age, sex, place of residence, medical history, completion of preoperative laboratory and diagnostic assessments, dental treatment performed under GA, operative time, anesthesia time, postoperative complications, total treatment cost, and calendar year of the procedure. Total treatment cost was recorded as the single amount billed per session; component costs are not itemized in the hospital billing system, and costs were analyzed as billed without inflation adjustment because group composition was stable across the study period (Section 3.1). Dental treatment was classified into three categories: caries treatment (restorative and pulp procedures), surgical treatment (surgical extractions (including odontoma removal, supernumerary tooth extraction, and impacted tooth extraction), frenectomy, and other surgical procedures), and combined treatment (caries and surgical procedures performed during the same session).

As an objective measure of treatment extent, the number of teeth treated during each session was recorded from the operative note. Teeth were counted if they received a restoration, pulp therapy, crown, fissure sealant, or extraction. The induction and emergence interval was calculated as anesthesia time minus operative time.

Preanesthetic evaluations included blood tests, urinalysis, electrocardiography (ECG), and chest radiography. Completion status was recorded for each GA session, and evaluations that could not be completed because of patient non-cooperation were classified as incomplete. To minimize information bias, two investigators (NO and JYS) independently extracted data using a standardized collection form, with discrepancies resolved by consensus.

2.3 Classification of medical status

Patients were classified into two groups according to medical status. The Healthy group included patients with no underlying

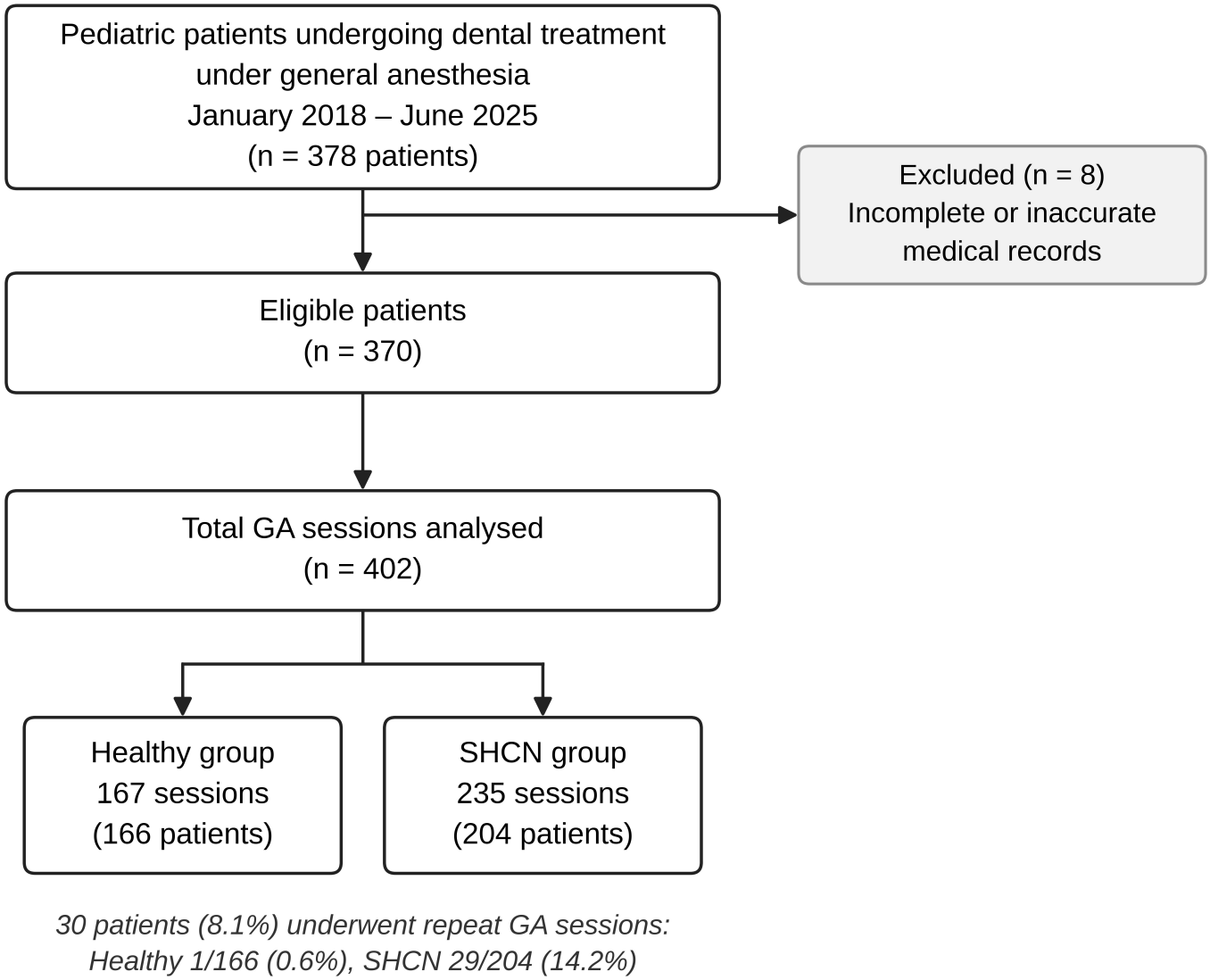


FIGURE 1. Flowchart of study-population selection and allocation to study groups. Of 378 patients identified, 8 were excluded because of incomplete or inaccurate records, leaving 370 patients who contributed 402 GA sessions. Thirty patients (8.1%) underwent more than one session; therefore, the number of sessions exceeded the number of patients. GA: general anesthesia; SHCN: Special Health Care Needs.

systemic condition and no registered disability, whereas the SHCN group included patients with dental severe disability, other systemic medical conditions (*e.g.*, congenital heart disease or neurological disorders), or both.

"Dental severe disability" is a Korean health-insurance reimbursement category rather than a dental diagnosis and does not indicate the severity of dental disease. Under the additional reimbursement scheme for dental care of registered persons with disabilities, operated by the National Health Insurance Service since October 2012, four registered disability categories qualify for an additional fee for specified dental procedures: brain lesion-related disability (including cerebral palsy), intellectual disability, psychiatric disability, and autism spectrum disorder, as defined by the Ministry of Health and Welfare of the Republic of Korea [20, 21]. The additional fee is intended to offset the specialized equipment, extended chair time, and additional personnel required for care in these groups; thus, eligibility reflects the national disability registration system and anticipated resource needs rather than findings on dental examination.

For descriptive analyses, the SHCN group was further divided into three subgroups—Dental Severe Disability, Medical Comorbidity, and Both Conditions—following the classification used by Jeong *et al*. [9] in a comparable Korean pediatric dental GA cohort. International studies have used more granular schemes, including seven diagnosis-based categories in a population-based Canadian study [12]. The three-subgroup structure was retained to facilitate comparison with the Korean literature and because subgroup sizes did not support finer stratification. For the primary between-group analyses, the three subgroups were pooled into a single SHCN group, and comparisons were performed between the Healthy group (n = 167) and SHCN (n = 235) groups. The three SHCN subgroups were also compared descriptively.

Among the 208 sessions involving dental severe disability (167 in the Dental Severe Disability subgroup and 41 in the Both Conditions subgroup), qualifying registrations included autism spectrum disorder (108, 51.9%), intellectual disability

(72, 34.6%), and brain lesion-related disability (38, 18.3%). Ten sessions (4.8%) involved patients registered under two qualifying categories; these categories were, therefore, not mutually exclusive. No patient held a psychiatric disability registration. Other registered disability types comprising physical, visual, hearing, speech, facial, and internal-organ disabilities, including epilepsy, do not attract the surcharge and were classified as medical comorbidity rather than dental severe disability. In this cohort, every child with one of these other registrations also had one of the four dental severe disability registrations and was, therefore, assigned to the Both Conditions subgroup (22 sessions); accordingly, the Medical Comorbidity subgroup comprised children with systemic disease only. Attention-deficit/hyperactivity disorder and anxiety disorders are not eligible for registration under this system. One session involved a child for whom attention-deficit/hyperactivity disorder was the only recorded diagnosis; because neither classification criterion was met, this session was assigned to the Healthy group. Systemic conditions in the Medical Comorbidity and Both Conditions subgroups most commonly included congenital heart disease, followed by hematologic or oncologic disease, skeletal or genetic syndromes, and renal, respiratory, gastrointestinal, or endocrine conditions.

2.4 Statistical analysis

Data were managed using Microsoft Excel (Microsoft 365, Microsoft Corporation, Redmond, WA, USA), and statistical analyses were performed using IBM SPSS Statistics version 21.0 for Windows (IBM Corp., Armonk, NY, USA). Categorical variables are summarized as frequencies and percentages, and continuous variables as medians and interquartile ranges (IQR). Normality was assessed using the Shapiro–Wilk test. Between-group differences in categorical variables were evaluated using the chi-square test (with continuity correction for 2×2 tables) or Fisher's exact test, as appropriate. Continuous variables were compared using the Mann–Whitney U test because all continuous variables were non-normally distributed in both groups (Shapiro–Wilk test, $p < 0.05$).

Because the groups differed in age, sex, and treatment category, unadjusted comparisons were considered descriptive, whereas multivariable regression models formed the primary inferential analysis. Operative time, anesthesia time, induction and emergence time, and total treatment cost were natural-log-transformed to reduce right skewness and analyzed using linear regression. Coefficients were back-transformed and are reported as percentage differences with 95% confidence intervals (CI). For each continuous outcome, Model 1 was unadjusted, and Model 2 was adjusted for age, sex, treatment category (entered as two indicator variables with caries treatment as the reference), and number of teeth treated. The distribution of GA sessions across calendar years was compared between groups using the chi-square test to assess potential confounding by temporal trends. Incomplete preanesthetic evaluation was analyzed using binary logistic regression with the same covariates, and results are reported as odds ratios (OR) with 95% CI. Repeat GA was analyzed at the patient level (n = 370) rather than the session level. To explore how treatment mix and treatment extent might account for differences in operative time, the association between SHCN status and caries treatment alone was examined using logistic regression, and the association between SHCN status and number of teeth treated was examined using linear regression; both models were adjusted for age and sex.

Effect sizes for Mann–Whitney U tests are reported as r (calculated as $|Z|/\sqrt{N}$), and the Hodges–Lehmann median difference is additionally reported for the number of teeth treated. Means and standard deviations (SD) are provided in **Supplementary Table 1** to facilitate comparison with studies reporting parametric summaries. No multiple-testing correction was applied to the descriptive unadjusted comparisons because primary inference was based on the multivariable models; the implications of this decision are addressed in the Limitations section. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

3. Results

3.1 Overall characteristics

A total of 402 GA sessions were performed in 370 individual patients between January 2018 and June 2025; overall demographic and clinical characteristics are summarized in Table 1. The median age at the time of the procedure was 6.0 years (IQR 5.0–9.0); 267 sessions (66.4%) involved male patients, and 315 (78.4%) involved children residing in Jeju-si. Caries treatment alone was the most common treatment category (n = 296, 73.6%), followed by combined treatment (n = 79, 19.7%) and surgical treatment alone (n = 27, 6.7%). Median operative time was 133.0 minutes (IQR 85.0–190.0), median anesthesia time was 165.0 minutes (IQR 121.2–225.0), median number of teeth treated was 11.0 (IQR 8.0–14.0), and median total treatment cost was 1,777,969 Korean Won (KRW) (IQR 1,253,289–2,370,674), equivalent to approximately 1368 United States Dollars (USD) (IQR 964–1824) at an exchange rate of 1 USD ≈ 1300 KRW. At least one preanesthetic evaluation was incomplete in 132 sessions (32.8%), with ECG most frequently incomplete (26.4%).

The annual distribution of GA sessions is shown in Fig. 2, and age distributions by group are shown in Fig. 3. Group composition did not differ significantly across calendar years ($\chi^2 = 6.94$, $df = 7$, $p = 0.435$), reducing concern that temporal shifts in the proportion of SHCN patients materially confounded the between-group comparisons.

3.2 Comparison between the healthy and SHCN groups

Paired values are presented as Healthy versus SHCN, consistent with the column order in Table 2. The Healthy (n = 167) and SHCN (n = 235) groups differed in the three characteristics that motivated the multivariable analysis (Table 2). The proportion of male patients was higher in the SHCN group (59.9% *vs.* 71.1%; $p = 0.026$). The SHCN group was also older (median 6.0 years (IQR 5.0–8.0) *vs.* 7.0 years (IQR 5.0–11.0); $p < 0.001$; $r = 0.22$): 71.3% of Healthy sessions were in the 5–9-year age group, whereas the SHCN group included larger proportions of patients aged 10–14 years (21.3%) and 15–19

TABLE 1. Demographic and clinical characteristics of all GA sessions (n = 402).

Variable	n (%) or median (IQR)
Sex	
Male	267 (66.4)
Female	135 (33.6)
Age (yr)	
Median (IQR)	6.0 (5.0–9.0)
0–4	82 (20.4)
5–9	235 (58.5)
10–14	60 (14.9)
15–19	25 (6.2)
Residence	
Jeju-si	315 (78.4)
Seogwipo-si	87 (21.6)
Medical status	
Healthy	167 (41.5)
SHCN—Dental Severe Disability	167 (41.5)
SHCN—Medical Comorbidity	27 (6.7)
SHCN—Both Conditions	41 (10.2)
Treatment category	
Caries treatment	296 (73.6)
Surgical treatment	27 (6.7)
Combined	79 (19.7)
Number of teeth treated, median (IQR)	11.0 (8.0–14.0)
Incomplete pre-anesthetic evaluation[1]	
Any evaluation	132 (32.8)
ECG	106 (26.4)
Blood tests	46 (11.4)
Urinalysis	12 (3.0)
Chest radiography	12 (3.0)
Perioperative measures	
Operative time (min)	133.0 (85.0–190.0)
Anesthesia time (min)	165.0 (121.2–225.0)
Induction + emergence (min)	33.0 (29.0–39.0)
Total treatment cost (KRW)	1,777,969 (1,253,289–2,370,674)
Postoperative complications	2 (0.5)

SHCN: Special Health Care Needs; ECG: electrocardiography; KRW: Korean Won; IQR: interquartile range. [1]Evaluations not completed because of patient non-cooperation.

years (10.6%). Treatment category also differed ($p < 0.001$). Caries treatment alone was more common in the SHCN group (59.3% *vs.* 83.8%), whereas combined treatment (29.9% *vs.* 12.3%) and surgical treatment alone (10.8% *vs.* 3.8%) were more common in the Healthy group. Residence did not differ between groups ($p = 1.000$).

At least one preanesthetic evaluation was incomplete more than three times as often in the SHCN group (14.4% *vs.* 46.0%; $p < 0.001$). The difference was driven by incomplete ECG (10.2% *vs.* 37.9%; $p < 0.001$), blood tests (5.4% *vs.* 15.7%; $p = 0.002$), and urinalysis (0.6% *vs.* 4.7%; Fisher's exact test, $p = 0.018$). Incomplete chest radiography did not differ significantly between groups (1.2% *vs.* 4.3%; Fisher's exact test, $p = 0.134$).

In unadjusted comparisons, operative time (118.0 *vs.* 143.0 min; $p = 0.012$; $r = 0.13$), anesthesia time (153.0 *vs.* 185.0 min; $p = 0.001$; $r = 0.16$), induction and emergence time (30.0 *vs.* 35.0 min; $p < 0.001$; $r = 0.26$), and total treatment cost (1,688,204 *vs.* 1,851,082 KRW; $p < 0.001$; $r = 0.19$) were all higher in the SHCN group. Effect sizes for these outcomes

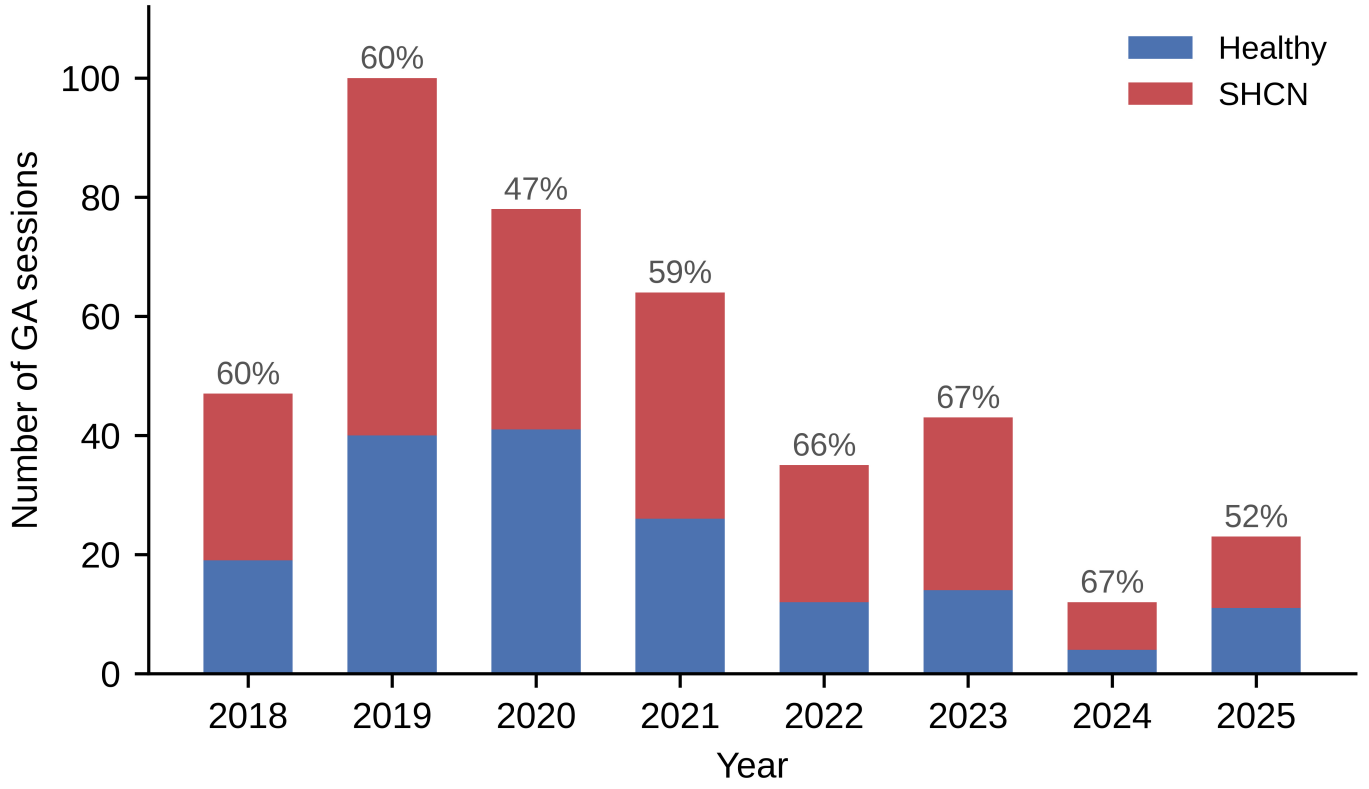


FIGURE 2. Annual distribution of general anesthesia sessions by study group. Bars show the number of sessions in the Healthy and SHCN groups, and percentages above the bars indicate the proportion of SHCN sessions in each year. Group composition did not differ across years (chi-square test, $p = 0.435$). The 2025 column includes January through June only. GA: general anesthesia; SHCN: Special Health Care Needs.

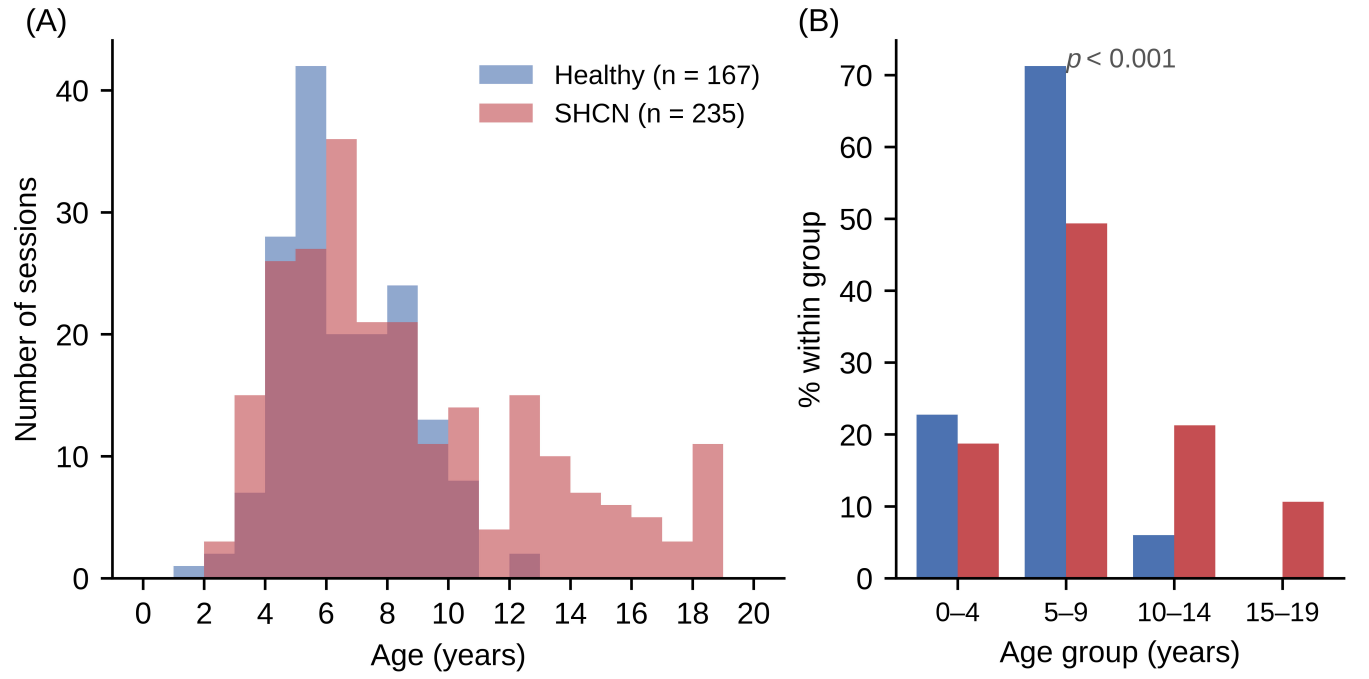


FIGURE 3. Age distribution of general anesthesia sessions in the Healthy and SHCN groups. (A) Session counts by single year of age. (B) Within-group percentage of sessions by age category. Data represent sessions (Healthy, n = 167; SHCN, n = 235). Age distributions differed between groups (chi-square test, $p < 0.001$). SHCN: Special Health Care Needs.

TABLE 2. Descriptive unadjusted comparison of demographic and clinical characteristics between the healthy and SHCN groups.

Variable	Healthy (n = 167)	SHCN (n = 235)	*p*-value
Sex			
Male	100 (59.9)	167 (71.1)	0.026
Female	67 (40.1)	68 (28.9)	
Age (yr)			
Median (IQR)	6.0 (5.0–8.0)	7.0 (5.0–11.0)	<0.001[2]; *r* = 0.22
0–4	38 (22.8)	44 (18.7)	<0.001
5–9	119 (71.3)	116 (49.4)	
10–14	10 (6.0)	50 (21.3)	
15–19	0 (0.0)	25 (10.6)	
Residence			
Jeju-si	131 (78.4)	184 (78.3)	1.000
Seogwipo-si	36 (21.6)	51 (21.7)	
Treatment category			
Caries treatment	99 (59.3)	197 (83.8)	<0.001
Surgical treatment	18 (10.8)	9 (3.8)	
Combined	50 (29.9)	29 (12.3)	
No. of teeth treated, median (IQR)	9.0 (6.0–12.0)	12.0 (10.0–15.0)	<0.001[2]; *r* = 0.31
Incomplete preanesthetic evaluation[1]			
Any evaluation	24 (14.4)	108 (46.0)	<0.001
ECG	17 (10.2)	89 (37.9)	<0.001
Blood tests	9 (5.4)	37 (15.7)	0.002
Urinalysis	1 (0.6)	11 (4.7)	0.018[3]
Chest radiography	2 (1.2)	10 (4.3)	0.134[3]
Perioperative measures			
Operative time (min)	118.0 (83.5–175.5)	143.0 (86.5–201.0)	0.012[2]; *r* = 0.13
Anesthesia time (min)	153.0 (115.0–206.0)	185.0 (128.0–236.5)	0.001[2]; *r* = 0.16
Induction + emergence (min)	30.0 (26.0–35.5)	35.0 (30.0–40.0)	<0.001[2]; *r* = 0.26
Total treatment cost (KRW)	1,688,204 (1,064,032–2,205,861)	1,851,082 (1,462,823–2,550,324)	<0.001[2]; *r* = 0.19

Data are presented as n (%) for categorical variables and median (IQR) for continuous variables. p-values are from the chi-square test unless otherwise indicated. [1]Evaluations not completed because of patient non-cooperation. [2]Mann–Whitney U test (Shapiro–Wilk $p < 0.05$). [3]Fisher's exact test (applied when any expected cell count <5). For 2 × 2 tables, continuity-corrected chi-square p-values are reported. Effect sizes are reported as r (calculated as $|Z|/\sqrt{N}$); values of 0.1, 0.3, and 0.5 correspond to small, medium, and large effects, respectively. Because inference rests on the multivariable models, these unadjusted comparisons are descriptive and were not corrected for multiple testing. SHCN: Special Health Care Needs; ECG: electrocardiography; KRW: Korean Won; IQR: interquartile range.

were small; the number of teeth treated showed a medium effect ($r = 0.31$). Full distributions are presented in Table 2.

3.3 Extent of dental treatment

The number of teeth treated per session was significantly higher in the SHCN group (median 9.0, IQR 6.0–12.0 in Healthy *vs.* 12.0, IQR 10.0–15.0 in SHCN; Mann–Whitney U test, $p < 0.001$; $r = 0.31$; Hodges–Lehmann median difference, +3.0 teeth). This corresponds to approximately one-third more teeth treated per SHCN session.

3.4 Multivariable analysis of perioperative outcomes and cost

Adjusted estimates are presented in Table 3 and Fig. 4. The unadjusted difference in operative time (+18.6%, 95% CI +5.7 to +33.1; $p = 0.004$) was attenuated after adjustment for age, sex, treatment category, and number of teeth treated (−9.3%, 95% CI −18.3 to +0.6; $p = 0.065$). Anesthesia time showed the

TABLE 3. Multivariable models of perioperative outcomes and total treatment cost (n = 402).

Outcome/model	Estimate for SHCN *vs.* Healthy (95% CI)	Other significant determinants	*p*-value (SHCN)
Operative time			
Model 1 (unadjusted)	+18.6% (+5.7 to +33.1)	—	0.004
Model 2[1]	−9.3% (−18.3 to +0.6)	Teeth treated, age, treatment category	0.065
Anesthesia time			
Model 1 (unadjusted)	+17.0% (+7.1 to +27.8)	—	<0.001
Model 2[1]	−4.9% (−12.3 to +3.0)	Teeth treated, age, treatment category	0.220
Total Treatment cost			
Model 1 (unadjusted)	+25.7% (+14.0 to +38.7)	—	<0.001
Model 2[1]	+3.1% (−4.5 to +11.2)	Teeth treated, age, treatment category	0.440
Induction + emergence time			
Model 1 (unadjusted)	+13.6% (+8.3 to +19.3)	—	<0.001
Model 2[1]	+12.0% (+6.1 to +18.2)	Age	<0.001
Incomplete evaluation (OR)[2]			
Model 1 (unadjusted)	OR 5.07 (3.06 to 8.38)	—	<0.001
Model 2[1]	OR 4.20 (2.44 to 7.24)	Treatment category	<0.001

For continuous outcomes, estimates are back-transformed coefficients from linear regression on the natural-log scale and are expressed as percentage differences. Incomplete evaluation was analyzed using binary logistic regression and is expressed as OR. [1]Adjusted for age, sex, treatment category, and number of teeth treated. [2]At least one incomplete preanesthetic evaluation. CI: confidence interval; OR: odds ratio; SHCN: Special Health Care Needs.

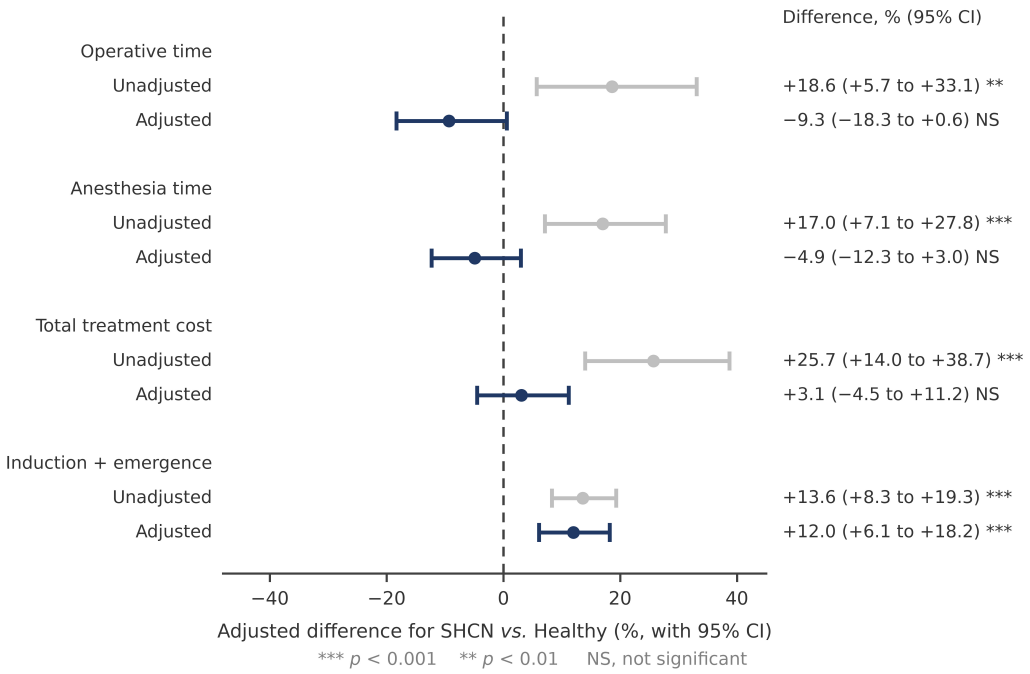


FIGURE 4. Unadjusted and adjusted differences between the SHCN and Healthy groups in perioperative outcomes and total treatment cost. Points represent back-transformed coefficients for SHCN status from linear regression on the natural-log scale, expressed as percentage differences; horizontal bars indicate 95% CIs, and the dashed vertical line indicates no difference. Two models are shown for each outcome, corresponding to Models 1 and 2 in Table 3. Incomplete preanesthetic evaluation is not shown because it is expressed as an odds ratio. CI: confidence interval; SHCN: Special Health Care Needs.

same pattern (+17.0% unadjusted; −4.9%, 95% CI −12.3 to +3.0; $p = 0.220$ adjusted). The unadjusted difference in total treatment cost (+25.7%, 95% CI +14.0 to +38.7; $p < 0.001$) was also attenuated after adjustment (+3.1%, 95% CI −4.5 to +11.2; $p = 0.440$).

In the adjusted model for operative time, significant determinants were number of teeth treated (+6.0% per additional tooth; $p < 0.001$), age (+2.2% per year; $p = 0.002$), and treatment category, with surgical treatment associated with shorter operative time than caries treatment (−29.7%; $p < 0.001$). SHCN status was not statistically significant at the conventional threshold (−9.3%, 95% CI −18.3 to +0.6; $p = 0.065$). The model explained 36.8% of the variance in operative time.

Two analyses adjusted for age and sex further clarified this pattern. SHCN patients had higher odds of receiving caries treatment alone (OR 4.75, 95% CI 2.81–8.02; $p < 0.001$) and had 2.8 more teeth treated per session (95% CI +1.8 to +3.8; $p < 0.001$). Caries treatment was the longest procedure category (median 142.0 min) compared with combined (111.0 min) and surgical (50.0 min) treatment; combined sessions also involved fewer teeth than caries-only sessions (median 9.0 *vs.* 12.0 teeth). Within caries-only treatment, however, operative times were nearly identical between groups (139.0 min in Healthy *vs.* 145.0 min in SHCN; $p = 0.97$), while operative time per tooth was shorter in the SHCN group (13.7 *vs.* 11.9 min; $p = 0.021$).

By contrast, the induction and emergence interval remained significantly longer in the SHCN group after adjustment (+13.6% unadjusted; +12.0% adjusted, 95% CI +6.1 to +18.2; $p < 0.001$), despite adjustment for treatment category and number of teeth treated.

SHCN status was also strongly associated with incomplete preanesthetic evaluation. The unadjusted OR was 5.07 (95% CI 3.06–8.38; $p < 0.001$), and the association remained after adjustment (OR 4.20, 95% CI 2.44–7.24; $p < 0.001$). Age and sex were not significant determinants.

3.5 Comparison of SHCN subgroups

Descriptive characteristics of the three SHCN subgroups are presented in Table 4. The subgroups differed in age ($p = 0.001$) but not in sex distribution, operative time, anesthesia time, total treatment cost, or number of teeth treated (all $p \geq 0.13$). Induction and emergence time did not differ significantly between the subgroups ($p = 0.095$). The Both Conditions subgroup did not show the longest operative times or the highest costs; its medians for both were comparable to, or lower than, those of the other two subgroups.

Preanesthetic evaluation completion differed markedly across SHCN subgroups ($\chi^2 = 22.07$, $df = 2$; $p < 0.001$; Fig. 5). At least one evaluation was incomplete in 52.1% of Dental Severe Disability sessions and 48.8% of Both Conditions sessions, compared with only 3.7% (1 of 27) of Medical Comorbidity sessions, which was below the Healthy-group rate of 14.4%. Thus, incomplete evaluation was concentrated in subgroups with dental severe disability registration rather than in patients with medical comorbidity alone.

3.6 Repeat general anesthesia sessions

The 402 sessions were delivered to 370 individual patients: 340 patients (91.9%) underwent one GA session, 28 (7.6%) underwent two sessions, and 2 (0.5%) underwent three sessions. Repeat GA was strongly associated with medical status: only 1 of 166 Healthy patients (0.6%) underwent a repeat session, compared with 29 of 204 SHCN patients (14.2%) ($\chi^2 = 20.97$, $df = 1$; $p < 0.001$).

3.7 Postoperative complications

Two cases of aspiration pneumonia requiring hospitalization were recorded (0.5% of sessions). Both occurred in SHCN patients undergoing caries treatment, aged 12 and 13 years, and both had completed the full preanesthetic evaluation. Given the small number of events, no formal statistical test of the association between evaluation completion and postoperative complications was undertaken.

4. Discussion

This retrospective study analyzed 402 dental GA sessions in 370 pediatric patients over 7.5 years at Jeju National University Hospital. SHCN patients accounted for the majority of the GA population (58.5%). In unadjusted comparisons, the SHCN group had longer operative and anesthesia times, higher treatment costs, and a substantially higher frequency of incomplete preanesthetic evaluation. After adjustment for age, sex, treatment category, and number of teeth treated, differences in operative time, anesthesia time, and cost were attenuated and no longer statistically significant. In contrast, a longer induction and emergence interval and higher odds of incomplete preanesthetic evaluation remained associated with SHCN status, and repeat GA was markedly more frequent among SHCN patients.

Male patients predominated in the overall cohort (66.4%), consistent with pediatric dental GA studies from Turkey [5], India [14], Saudi Arabia [13], and Korea [9, 16]. Al-Khotani *et al.* [13] likewise reported a higher proportion of males among SHCN patients, consistent with the known male predominance of neurodevelopmental conditions such as ASD and intellectual disability [22]. The 5–9-year age group accounted for 58.5% of sessions, corresponding to primary and early mixed dentition, when caries burden may be high and cooperation with conventional treatment can remain limited [1, 3]. This age range also overlaps the typical period for surgical management of supernumerary teeth, which commonly present between 5 and 7 years of age and may require GA because of procedural complexity and limited cooperation [23]. Similar to our findings, Sevekar *et al.* [14] and Ciftci and Yazicioglu [5] reported that healthy children undergoing dental GA were younger than their SHCN counterparts. Most patients resided in Jeju-si (78.4%), broadly reflecting the population distribution of Jeju Island, and residence did not differ between groups.

The SHCN proportion in our cohort (58.5%) falls within the approximately 27%–60% range reported across international institutional settings [9, 13–15]. Variation across studies is expected because referral pathways, institutional roles, and source populations differ. Two factors may contribute to

TABLE 4. Comparison of the three SHCN subgroups.

Variable	Dental Severe Disability (n = 167)	Medical Comorbidity (n = 27)	Both Conditions (n = 41)	*p*-value
Age (yr)	7.0 (6.0–12.0)	5.0 (4.0–7.0)	7.0 (4.0–12.0)	0.001[1]
Male, n (%)	125 (74.9)	17 (63.0)	25 (61.0)	0.132[2]
Operative time (min)	143.0 (84.0–201.0)	160.0 (100.0–205.0)	141.0 (100.0–183.0)	0.761[1]
Anesthesia time (min)	180.0 (125.0–238.0)	195.0 (132.0–232.0)	180.0 (143.0–215.0)	0.826[1]
Induction + emergence (min)	35.0 (30.0–40.0)	32.0 (30.0–38.0)	35.0 (32.0–45.0)	0.095[1]
Total treatment cost (KRW)	1,866,365 (1,480,887–2,524,077)	2,235,141 (1,542,247–2,663,224)	1,779,529 (1,203,356–2,365,837)	0.387[1]
No. of teeth treated	12.0 (9.0–15.0)	12.0 (10.0–15.0)	14.0 (11.0–16.0)	0.222[1]
Incomplete evaluation, n (%)	87 (52.1)	1 (3.7)	20 (48.8)	<0.001[2]

Data are medians (IQR) unless otherwise stated. [1]Kruskal–Wallis test. [2]Chi-square test. Costs are reported in Korean Won. For reference, the corresponding rate of incomplete evaluation in the Healthy group was 14.4%. Estimates for the Medical Comorbidity subgroup (n = 27) should be interpreted descriptively because of the small sample size. SHCN: Special Health Care Needs; IQR: interquartile range; KRW: Korean Won.

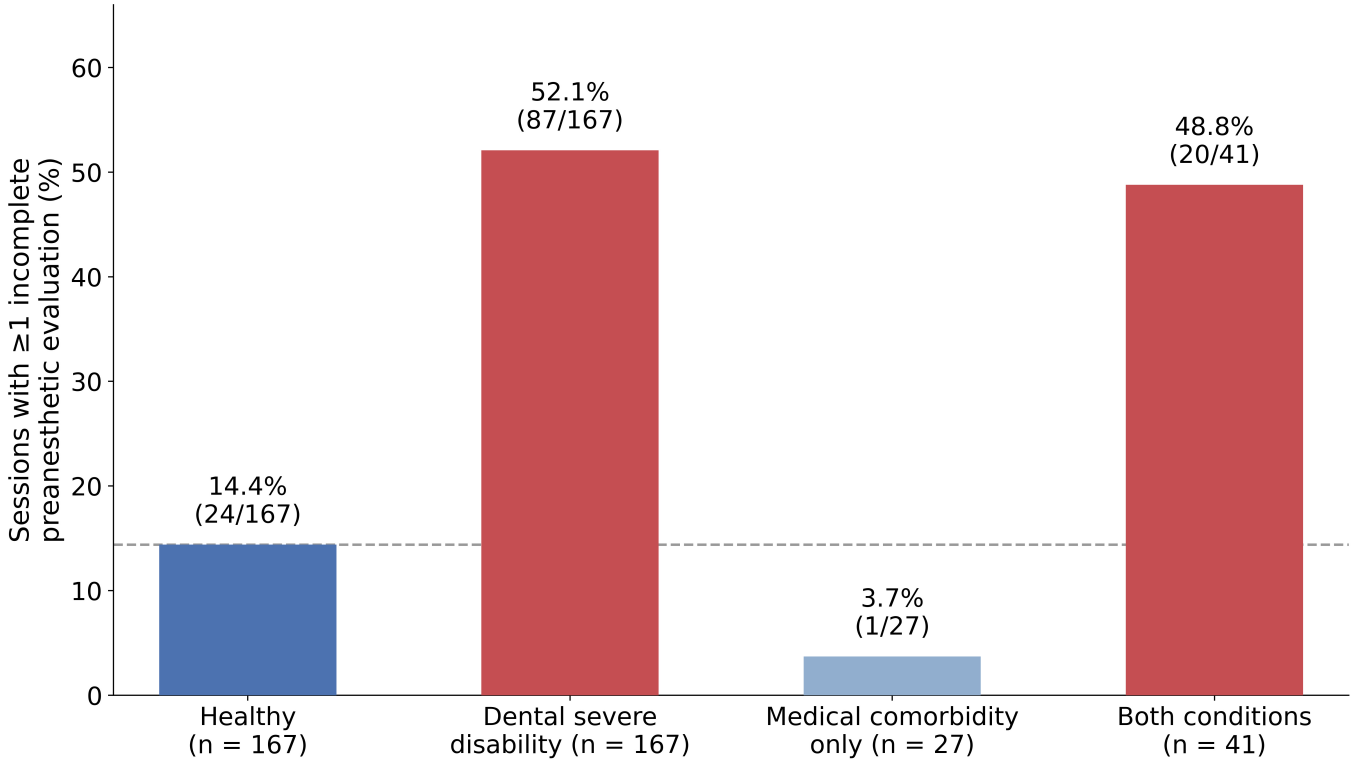


FIGURE 5. Incomplete preanesthetic evaluation by group and SHCN subgroup. Bars show the percentage of sessions with at least one incomplete evaluation, with numerators and denominators displayed above each bar; the dashed line indicates the Healthy-group rate. Red bars denote subgroups with a dental severe disability registration, and blue bars denote groups without such a registration. "Medical comorbidity only" indicates SHCN status arising from a systemic condition alone. The three SHCN subgroups differed significantly (chi-square test, $p < 0.001$). SHCN: Special Health Care Needs.

the relatively high SHCN proportion at our center. First, otherwise healthy uncooperative children may have alternative management options, including conscious sedation in primary or secondary care, whereas SHCN patients may more often require the perioperative resources and specialist expertise of tertiary centers. Second, Jeju National University Hospital is both the sole provider of dental treatment under GA on Jeju Island and the government-designated Regional Oral Health Care Center for Persons with Disabilities in the Jeju region [20], which likely concentrates SHCN referrals.

The SHCN group was older than the Healthy group (Table 2), likely reflecting differences in the indications for GA. Among Healthy patients, GA was commonly associated with surgical procedures such as supernumerary tooth extraction and with extensive caries treatment in younger children who could not cooperate with conventional outpatient care. Within

the SHCN group, older ages were concentrated in the two subgroups with dental severe disability (median 7.0 years in both), whereas the Medical Comorbidity subgroup had a median age of 5.0 years (Kruskal–Wallis $p = 0.001$; Table 4). Because the Medical Comorbidity subgroup included only 27 sessions and no pairwise tests were performed, this finding should be interpreted descriptively. One possible explanation is that behavioral barriers associated with ASD, intellectual disability, or cerebral palsy may persist with age, allowing the need for GA to extend into adolescence.

Treatment-category distribution differed substantially between groups: caries treatment alone predominated in the SHCN group, whereas combined and surgical treatment were more frequent in the Healthy group (Table 2). This pattern is consistent with differing indications for GA. In otherwise healthy children, caries can often be managed with less intensive behavior guidance or sedation, and GA may therefore be reserved more often for surgical procedures such as extraction of supernumerary, odontoma-associated, or impacted teeth. In SHCN patients, persistent difficulty with cooperation, challenges in maintaining oral hygiene, and barriers to routine preventive care [6, 24, 25] may contribute to a greater caries burden and the need for comprehensive restorative treatment under GA. Jeong *et al.* [9] reported a similar pattern, with restorative treatment predominating in disabled patients (68.1%) and surgical procedures predominating in nondisabled patients (64.7%) at a Korean university dental hospital. Our data add a further dimension to this observation: alongside the difference in treatment category, the number of teeth treated per session was higher in the SHCN group (median 9.0 in Healthy *vs.* 12.0 in SHCN; $p < 0.001$).

Operative time, anesthesia time, and total treatment cost were higher in SHCN sessions in unadjusted analyses, but these differences did not persist after adjustment for age, sex, treatment category, and number of teeth treated. In the fully adjusted model, operative-time model, number of teeth treated, patient age, and treatment category were significant predictors, whereas SHCN status was not statistically significant at the conventional threshold (−9.3%, 95% CI −18.3 to +0.6; $p = 0.065$).

The attenuation of the adjusted difference should not be interpreted as evidence that SHCN status has no implications for operating-room use. In this cohort, SHCN sessions were associated with a different treatment mix and a greater number of teeth treated; these factors may lie on the pathway linking SHCN status to total operative time. Adjustment for them, therefore, estimates the residual difference for comparable treatment burden rather than the total service-level difference. This interpretation is supported by the nearly identical operative times within caries-only sessions and the shorter operative time per treated tooth in the SHCN group. Thus, the unadjusted excess in operative time appears to reflect greater treatment volume rather than slower delivery of a given dental procedure.

One perioperative difference persisted after adjustment. The induction and emergence interval—the portion of anesthesia time not attributable to the dental procedure—remained approximately 12% longer in the SHCN group ($p < 0.001$). The absolute difference was modest (median 30.0 min in Healthy *vs.* 35.0 min in SHCN) but specific to the anesthetic transition period. This additional time may reflect greater demands during induction, airway management, positioning, and recovery in patients with limited cooperation. The additional anesthetic burden associated with SHCN status, therefore, appears to be concentrated in these transitions rather than in the dental procedure itself.

Incomplete preanesthetic evaluation was more than three times as frequent in the SHCN group, most commonly because of incomplete ECG (Table 2). The association remained strong after adjustment (adjusted OR 4.20), indicating that it was not explained by the measured differences in age, sex, treatment category, or number of teeth treated. To our knowledge, this is the first study to directly compare preanesthetic evaluation completion between Healthy and SHCN pediatric patients undergoing dental GA. A single-center Italian series of 41 uncooperative children with special needs reported similar practical difficulties: blood sampling could not be obtained in 41.5% and ECG in 17.1%, with outstanding tests completed after induction of anesthesia [26, 27]. Because that series lacked a healthy comparison group, no direct external benchmark is available for the between-group difference observed here. At our institution, an incomplete outpatient evaluation does not mean that anesthesia proceeds without the missing information; outstanding tests are obtained on the day of surgery after sedation and before dental treatment proceeds. The principal consequence is therefore operational, requiring additional time, staffing, and scheduling capacity. Both postoperative complications in this cohort occurred despite complete preanesthetic evaluation, and with only two events, no relationship between evaluation completion and adverse outcomes could be assessed.

The subgroup analysis further localized the difficulty in completing preanesthetic evaluation. Incomplete evaluation occurred in 52.1% of Dental Severe Disability sessions and 48.8% of Both Conditions sessions, but in only 3.7% of Medical Comorbidity sessions, below the Healthy-group rate of 14.4% (Fig. 5). This pattern suggests that the difficulty was more closely associated with developmental or behavioral disability than with systemic medical comorbidity alone, although the Medical Comorbidity subgroup was small. Potential barriers include difficulty remaining still, limited comprehension of instructions, involuntary movement, and sensory sensitivity; tailored interventions may, therefore, need to address several distinct sources of non-cooperation.

Preanesthetic testing practice varies considerably across institutions and healthcare systems. International guidance favours selective, rather than routine testing, in healthy children: neither the American Society of Anesthesiologists (ASA) Practice Advisory nor pediatric-specific recommendations endorse routine ECG, laboratory testing, urinalysis, or chest radiography in ASA I–II children undergoing low-risk procedures [28, 29]. A uniform battery is nonetheless applied at our institution to all children scheduled for dental GA, in line with institutional protocol. Selective indications for ECG and chest radiography include neuromuscular disease, congenital heart disease, and obstructive sleep apnea—conditions represented in our SHCN subgroups [28]. The disparity we report, therefore, concerns tests that were largely discretionary in the Healthy group, but

selectively indicated in a substantial part of the SHCN group, and completion rates should be read in that light.

The pattern of incomplete evaluation also varied by test. ECG had the highest incompletion rate, consistent with the sensitivity of tracing quality to even brief involuntary movement. Chest radiography and urinalysis had the lowest incompletion rates (3.0% each), and chest radiography did not differ significantly between groups ($p = 0.134$). Blood sampling showed an intermediate incompletion rate (11.4%). These findings support the development of tailored preoperative pathways for patients who cannot complete routine testing. Desensitization visits, distraction techniques, and pharmacological preprocedural sedation may facilitate test completion in selected patients [3, 6].

A third finding independent of case mix was the frequency of repeat GA, which was substantially more common among SHCN patients (14.2% *vs.* 0.6%). Our records did not document the reasons for repeat sessions, but for children with dental severe disability, the behavioral barrier is unlikely to resolve, and continuing accumulation of disease may bring some patients back for further treatment. Planning for regional GA capacity may, therefore, need to account for a proportion of patients who return, rather than assuming a single episode per patient.

The overall postoperative complication rate was low (0.5%), with two cases of aspiration pneumonia requiring hospitalization. This finding is consistent with reports of low rates of major postoperative complications after pediatric dental GA across different institutional settings [4, 8, 13, 30].

Taken together, these findings refine the interpretation of the perioperative burden associated with SHCN. The prevailing account in the comparative literature—that these patients require longer procedures because their care is more complex [5, 13, 14]—was not supported once case mix was accounted for. A recent study comparing children with and without ASD reached a similar conclusion: multivariable models identified caries burden and physical status, rather than autism diagnosis itself, as predictors of longer operative and anesthesia times, while children with autism underwent shorter procedures when fewer teeth required treatment [31]. The fact that an independent cohort reached a similar conclusion supports a treatment-burden rather than a diagnosis-only interpretation, though confirmation in other populations is needed. Service improvement may, therefore, benefit from combining tailored preoperative assessment and desensitization pathways with scheduling and regional capacity planning that account for both treatment volume and repeat GA demand.

This study has several limitations. First, its retrospective, single-center design limits control of residual confounding and may restrict generalizability beyond the regional setting studied. Second, the 402 sessions were contributed by 370 patients, and 30 patients underwent more than one session; this within-patient correlation was not modeled, although repeat sessions involved only 8.1% of patients. Third, the descriptive comparisons in Table 2 included multiple significance tests without formal correction. A Bonferroni adjustment across the 15 reported comparisons ($\alpha = 0.0033$) would render the differences in operative time ($p = 0.012$), sex distribution ($p = 0.026$), and incomplete urinalysis ($p = 0.018$) non-significant, whereas the key findings for induction and emergence time, incomplete evaluation, and repeat GA would remain below the adjusted threshold. Fourth, treatment category and number of teeth treated may act as mediators rather than confounders of the association between SHCN status and operative time or cost. The adjusted models, therefore, estimate the residual difference after accounting for treatment burden, not the total association with SHCN status; both unadjusted and adjusted estimates are reported for this reason. Fifth, the preanesthetic testing battery at our institution is applied uniformly rather than selectively, so incomplete testing should not be interpreted as a direct measure of care quality. Finally, group assignment followed Korean reimbursement categories rather than the broader American Academy of Pediatric Dentistry definition of special health care needs, which also encompasses behavioral conditions such as attention-deficit/hyperactivity disorder. One patient had attention-deficit/hyperactivity disorder as the only recorded diagnosis and was classified as Healthy; reassigning that session to the SHCN group did not materially alter the findings (induction and emergence time +11.1%; adjusted OR for incomplete evaluation 4.11). Prospective, multicenter studies with standardized data collection would help confirm these findings and clarify the determinants of GA use and outcomes in geographically underserved pediatric populations.

5. Conclusions

This study provides an institutional characterization of pediatric dental GA at a regional center on Jeju Island. SHCN patients constituted the majority of cases and received treatment on more teeth per session. Although operative and anesthesia times and treatment costs were higher in unadjusted comparisons, these differences were attenuated after adjustment for case mix and treatment extent; within caries-only sessions, operative times were similar between groups. The additional service burden associated with SHCN, therefore, appears to reflect greater treatment volume rather than slower performance of a given dental procedure. In contrast, SHCN status remained associated with a longer induction and emergence interval and substantially higher odds of incomplete preanesthetic evaluation, while repeat GA was also markedly more frequent. Postoperative complications were uncommon (0.5%). These findings support SHCN-tailored preoperative assessment and perioperative management pathways, along with operating-room scheduling and regional capacity planning that account for greater treatment volume and recurrent GA demand.

ABBREVIATIONS

GA, general anesthesia; SHCN, special health care needs; ASD, autism spectrum disorder; ASA, American Society of Anesthesiologists; ECG, electrocardiography; KRW, Korean Won; IRB, Institutional Review Board; SD, standard deviation; CI, confidence interval; OR, odds ratio; IQR, interquartile range; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; USD, United States Dollar; EMR, electronic medical records.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available due to patient privacy considerations and institutional review board restrictions, but are available from the corresponding author on reasonable request.

AUTHOR CONTRIBUTIONS

NO—designed the research study, analyzed the data, and wrote the manuscript. JYS—contributed to data extraction from electronic medical records. Both authors contributed to editorial changes in the manuscript. Both authors read and approved the final manuscript.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of Jeju National University Hospital (approval number: JEJUNUH 2025-06-007). The requirement for individual informed consent was waived by the IRB owing to the retrospective nature of the study.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

SUPPLEMENTARY MATERIAL

Supplementary material associated with this article can be found, in the online version, at https://oss.jocpd.com/files/article/2117534165853192192/attachment/Supplementary%20material.docx.

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