Original Article

pISSN 2383-9309 ▮ eISSN 2383-9317
J Dent Anesth Pain Med 2023;23(5):265-271 ▮ https://doi.org/10.17245/jdapm.2023.23.5.265

Trends of conscious sedation in the Department of Pediatric Dentistry at the Dankook University Dental Hospital for 11 Years

Sohyun Park, Jongbin Kim, Jongsoo Kim, Joonhaeng Lee, Miran Han, Jisun Shin

Department of Pediatric Dentistry, School of Dentistry, Dankook University, Cheonan, Korea

Background: Anxiety and fear in children's dental care are major impediments to successful dental care. High-quality dental treatment can be achieved using various behavioral control methods; however, conscious sedation using drugs can be used if behavioral control is difficult, owing to excessive fear and anxiety. This study aimed to examine the trends in conscious sedation implemented in pediatric dentistry at the Dankook University Dental Hospital over the past 11 years.

Methods: This study included 6,438 cases of dental treatment under conscious sedation conducted over 11 years between January 2011 and December 2021 in the Department of Pediatric Dentistry at Dankook University Dental Hospital.

Results: Over the past 11 years, the number of dental treatments under sedation has increased. In the case of inhalation sedation using nitrous oxide, the rate of increase was approximately twice every year, and the use of midazolam gradually decreased. The average age of children who underwent sedation was 5.11 years, and the rate of sedation treatment in children aged <4 years tended to decrease, while that of children aged >5 years tended to increase. This is related to the trend of changes in drugs used. In a sex-based survey, sedation treatment rate was higher in males than that in females.

Conclusion: Appropriate selection of sedatives can reduce the frequency of general anesthesia and minimize complications through efficient and safe dental treatments. Trend analysis of sedation by year will help provide guidelines for the appropriate selection of sedation for dental treatment of children and patients with disability.

Keywords: Behavior Guidance; Conscious Sedation; Pediatric Dentistry.

INTRODUCTION

Anxiety and fear are major barriers to successful pediatric dental treatments. In many cases, it is possible to achieve treatment goals without conscious sedation using conventional behavioral control. However, a patient in a pre-cooperative stage or who severely refuses treatment due to excessive fear and anxiety can induce a positive psychological state through drug sedation [1].

In a survey on the use of sedation among members of the Korean Academy of Pediatric Dentistry, the proportion of members who responded that they used sedation was 29% in 1999; however, this increased to 66% in 2005 [2,3].

Additionally, among 181 respondents in a 2014 survey that targeted members of the Korean Academy of Dental Anesthesiology, 114 (63.0%) dentists responded that they

Received: May 15, 2023 • Revised: August 14, 2023 • Accepted: September 6, 2023
Corresponding Author: Jongbin Kim, Department of Pediatric Dentistry, School of Dentistry, Dankook University, 119 Dandaero, Dongnam-gu, Cheonan 31116, Korea
Tel: +82-41-550-1921 E-mail: jbkim0222@dankook.ac.kr

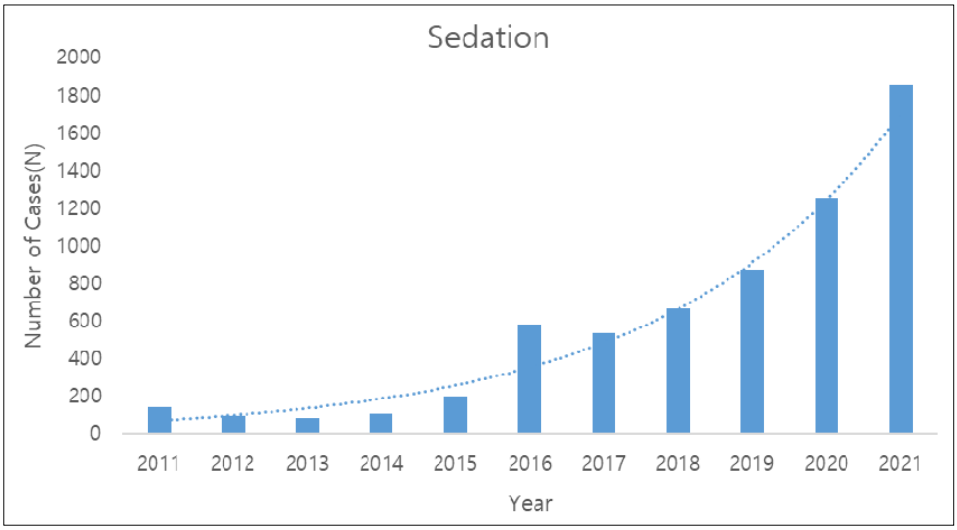

Fig. 1. Treatment with conscious sedation by year

practiced sedation [4]. Therefore, treatment under sedation with drugs is a trend that is steadily increasing in the field of pediatric dentistry.

As the frequency of sedation increases, the risk of complications also increase. However, there is a lack of data on the awareness and reality of sedation methods among pediatric dentists [5].

This study aimed to investigate changes in the use of conscious sedation techniques using data analysis of dental treatments performed at the Department of Pediatric Dentistry, Dankook University Dental Hospital, between 2011 and 2021. Additionally, we aimed to provide statistical data that will serve as a basis for future sedation guidelines.

METHODS

This study was approved by the Institutional Review Board (IRB) of the Dankook University Dental Hospital (IRB No: DKUDH IRB 2023-06-002). This study included 6,438 dental treatments performed under conscious sedation at the Department of Pediatric Dentistry, Dankook University Dental Hospital, between January 2011 and December 2021.

Data, including patient sex, age, sedation type, sedative agents, and date of operation, were collected from the patient medical records of the Order Communication System. The collected data were analyzed using Microsoft 365 (Microsoft Corporation WA, Redmond, USA).

RESULTS

1. Number of cases by year

The number of cases per year is shown in Figure 1. Between 2011 and 2021, the number of cases of conscious sedation procedures performed at the Department of Pediatric Dentistry, Dankook University Dental Hospital was 6,438. The number of cases steadily increased every year, particularly in 2016, 2020, and 2021.

2. Distribution of used sedative agents

The distribution of drugs used for sedation has changed significantly over the past 11 years. Between 2011 and 2014, chloral hydrate showed highest rate of sedation, and midazolam was not used. Since 2015, midazolam has been used for sedation, and in 2017 and 2018, it had the highest rate of sedation. In 2019, the use of nitrous oxide increased dramatically, accounting for more than half of

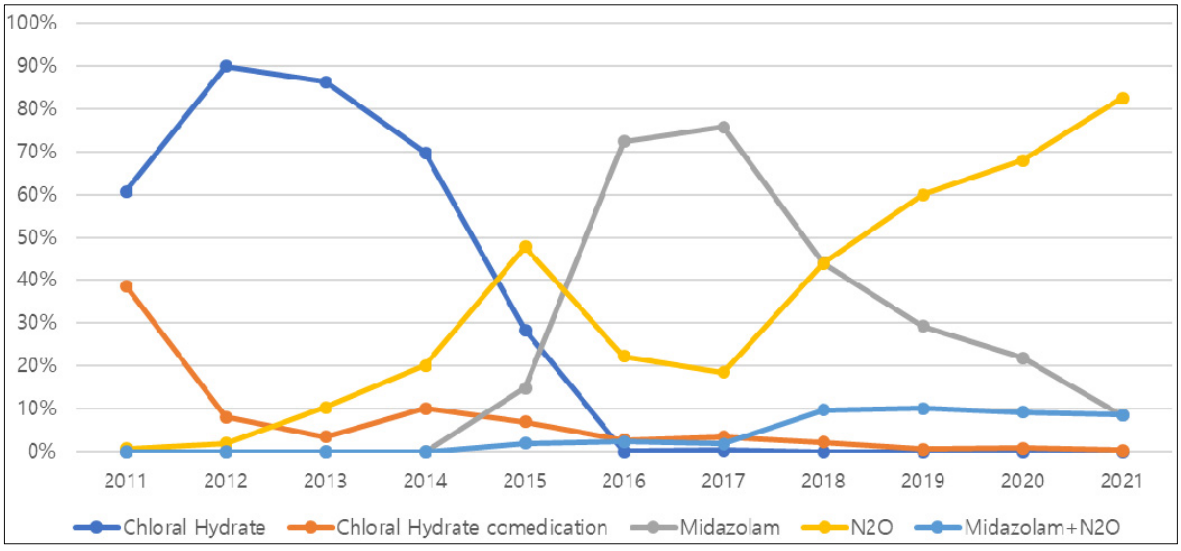

Fig. 2. Types of conscious sedative agents by year

Table 1. Type of conscious sedative agents by year

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Total
Chloral Hydrate	88 (60.7%)	89 (89.9%)	75 (86.2%)	83 (69.7%)	57 (28.3%)	1 (0.2%)	2 (0.4%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	395 (6.1%)
Chloral Hydrate Comedication	56 (38.6%)	8 (8.1%)	3 (3.4%)	12 (10.1%)	14 (7.0%)	16 (2.7%)	19 (3.5%)	15 (2.3%)	5 (0.6%)	11 (0.9%)	6 (0.3%)	165 (2.6%)
Midazolam	0 (0%)	0 (0%)	0 (0%)	0 (0%)	30 (14.9%)	421 (72.3%)	409 (75.7%)	294 (44.1%)	257 (29.4%)	276 (21.8%)	159 (8.6%)	1846 (28.7%)
N_2O	1 (0.7%)	2 (2.0%)	9 (10.3%)	24 (20.2%)	96 (47.8%)	130 (22.3%)	100 (18.5%)	293 (43.9%)	525 (59.9%)	858 (68.0%)	1535 (82.5%)	3573 (55.5%)
Midazolam + N_2O	0 (0%)	0 (0%)	0 (0%)	0 (0%)	4 (2.0%)	14 (2.4%)	10 (1.9%)	65 (9.7%)	89 (10.1%)	117 (9.3%)	160 (8.6%)	459 (7.1%)
Total	145 (100.0%)	99 (100.0%)	87 (100.0%)	119 (100.0%)	201 (100.0%)	582 (100.0%)	540 (100.0%)	667 (100.0%)	876 (100.0%)	1262 (100.0%)	1860 (100.0%)	6438 (100.0%)

N_2O, nitrous oxide

Table 2. Treatment with sedation by age

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Age 1-2	117	67	60	60	51	76	59	51	37	45	44
Age 3-4	27	31	18	37	51	290	268	333	332	416	546
Age 5-7	1	1	8	11	62	157	159	231	354	600	876
Age 8-11	0	0	0	9	31	55	48	47	149	189	363
Age ≥ 12	0	0	1	2	6	4	6	5	4	16	30

all sedation cases (Table 1 and Fig. 2).

3. Age distribution of patients receiving sedation

The number of cases by age is shown in Table 2, and the age distribution of patients by year for the total number of cases is shown in Figure 3. The average age of the patients was 5.11 years old, and the number of patients aged 3–4 years decreased annually. In contrast, the number of patients aged ≥ 5 years steadily increased, showing a trend of increasing age of patients by year.

4. Gender distribution of patients receiving sedation

The proportion of male patients who underwent sedation each year was higher than that of females (Fig.

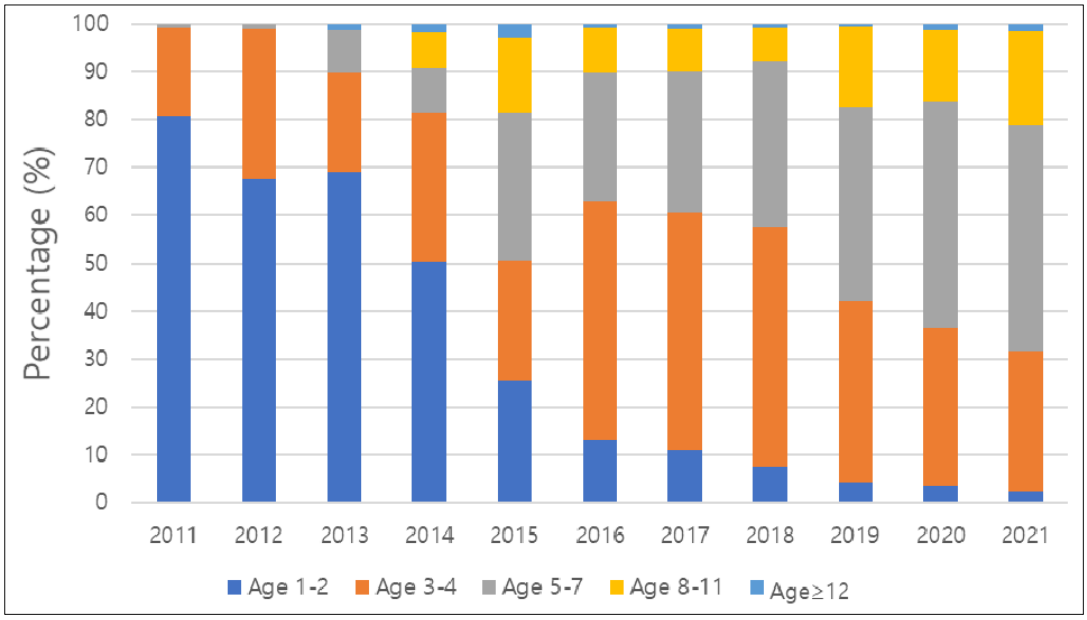

Fig. 3. Percentage of treatment cases with conscious sedation by age

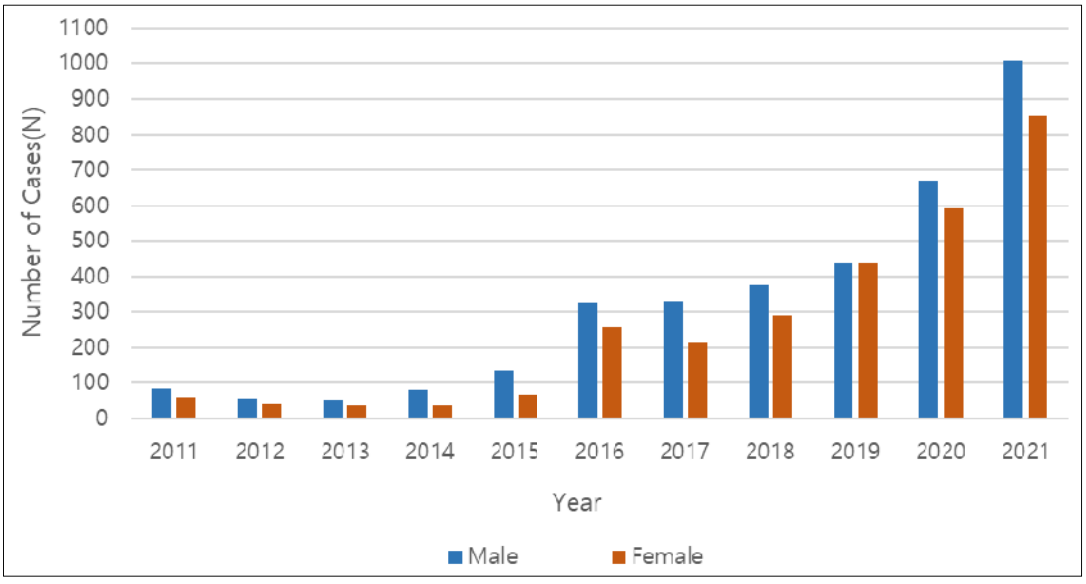

Fig. 4. Treatment with conscious sedation by sex

4). The number of males who underwent sedation for 11 years was 3,552 (55%), and the number of females was 2,886 (45%).

DISCUSSION

According to the investigation in this study, 6,438 cases of conscious sedation were performed in pediatric patients over a period of 11 years at the Department of Pediatric Dentistry, Dankook University Dental Hospital. The number of cases steadily increased every year, particularly in 2016, 2020, and 2021.

The drugs used for sedation were changed annually over an 11-year period. Between 2011 and 2014, chloral hydrate showed the highest rate of sedation, and

midazolam was not used. In 2017, intramuscular administration of midazolam was the most commonly used (75.7%); however, as the frequency of nitrous oxide inhalation sedation gradually increased, 82.5% of the total cases were nitrous oxide inhalation sedation in 2021. This was also related to changes in the safety awareness of pediatric dentists and residents. Since 2015, the Pediatric Advanced Life Support (PALS) has been implemented in pediatric dentistry, and the Department of Pediatric Dentistry at the Dankook University Dental Hospital provides PALS education to residents every year [6]. Accordingly, information on emergencies that may occur during the treatment of pediatric patients was acquired, and safer drugs for sedation of consciousness were selected. Sedation with nitrous oxide inhalation can be successfully applied not only to children with excessive fear or difficulty in controlling their behavior but also to the dental treatment of patients with severe nausea [7,8]. Additionally, compared to other sedation methods, the time required for expression and recovery is short, and the pharmacological action can be controlled; therefore, the stability is high [9,10]. A combined administration of midazolam and nitrous oxide also increased annually. The combined administration of these two drugs reduces side effects by decreasing the dose of midazolam [11]. In particular, the number of nitrous oxide cases in 2021 increased by approximately two times compared to that in the previous year, which is also related to an increase in the number of specialists in pediatric dentistry at the Dankook University Dental Hospital.

The average age of the patients in this study was 5.11 years, and the number of patients aged 3–4 years decreased every year, while the number of patients aged ≥ 5 years showed a tendency to steadily increase. In a 2021 study conducted by Tak et al. on pediatric dental patients who underwent sedation between 2002 and 2015, dental treatment using sedation in pediatric patients aged 0–5 years decreased over time, whereas that using sedation increased in those aged 6–8 years [12]. This age-related trend was also related to an increase in sedation with nitrous oxide inhalation. The most commonly used conscious sedation method in this study was nitrous oxide inhalation, whereas the most used conscious sedation method for five years between 2011 to 2015 was oral administration of chloral hydrate and hydroxyzine. There was no age limit for the use of nitrous oxide; however, according to a study conducted by Foley in 2005, nitrous oxide is effective for behavioral control in children aged > 5 years and is widely used in children aged > 10 years [13]. Increase in the average age of the population has also been associated with a decrease in the use of chloral hydrate. In dentistry, the recommended dose of chloral hydrate is 50 mg/kg, and the single maximum dose is 1 g. Chloral hydrate should not be used in children weighing > 20 kg, and is therefore contraindicated in children > 6 years [14]. As the use of chloral hydrate gradually decreased, the average age of the patients undergoing subconscious sedation increased. Additionally, according to a study conducted by Wilson in the United States in 2016, the ages at which sedation was used the most in pediatric dental treatment were 3 and 4–5 years. The proportion of patients aged < 2 years decreased, and largest increase was seen in those aged 6–10 years [15]. This change in the US was similar to that in this study, in which the age group that accounted for the largest proportion of patients who received sedation over the past 11 years changed from < 2 to 4-5 years and 6–10 years old. Regarding the decrease in sedation treatment in children aged < 2 years, it seems that the change in consciousness about sedation is reflected in the fact that the younger the patient, the lower the adaptability and drug acceptance, and that a small difference in drug dosage can lead to a large change in sedation depth [16].

Regarding the sex distribution of patients who underwent dental treatment under conscious sedation, the proportion of males was 55%, and that of females was 45%. According to the National Statistical Office's population trend survey data, the birth rate of males has been higher than that of females over the past five years. Corresponding to this result, the number of males who

visited pediatric dentistry was higher than that of females over the past 11 years, and the sex distribution of patients who underwent sedation also reflected this. Additionally, according to a study by Choi and Park in 2003, males showed higher anxiety than females in a dental environment, and according to a study by Boyar and Cross in 1997, the behavioral patterns of males before separation from their parents were worse than those of females [17,18]. Based on these results, it can be said that in the case of males, patients and dentists tend to prefer sedation.

Analysis of the number of cases of conscious sedation performed at the Department of Pediatric Dentistry, Dankook University Dental Hospital, between 2011 and 2021 revealed that the number of cases continued to increase each year. Among the methods of conscious sedation, the frequency of sedation by nitrous oxide inhalation has recently increased rapidly, and the average age of patients has increased annually. The rate of conscious sedation was higher in males than that in females.

In conclusion, the proper selection of sedative drugs can reduce the frequency of general anesthesia and minimize various complications through efficient and safe dental treatment. Trend analysis of sedation by year will help provide guidelines for the appropriate selection of sedation for dental treatment of children and patients with disability. As interest in dental treatment under conscious sedation is increasing, a multifaceted approach is important for the safe use of sedative drugs.

AUTHOR ORCIDs

Sohyun Park: https://orcid.org/0009-0009-8185-5740
Jongbin Kim: https://orcid.org/0000-0001-8744-9553
Jongsoo Kim: https://orcid.org/0000-0001-8752-332X
Joonhaeng Lee: https://orcid.org/0000-0002-3575-5476
Miran Han: https://orcid.org/0000-0003-0312-6023
Jisun Shin: https://orcid.org/0000-0003-2147-5163

AUTHOR CONTRIBUTIONS

Sohyun Park: Writing - original draft
Jongbin Kim: Supervision, Writing - review & editing
Jongsoo Kim: Supervision
Joonhaeng Lee: Supervision
Miran Han: Supervision
Jisun Shin: Supervision

DECLARATION OF INTEREST: No potential conflict of interest was reported by the authors.

REFERENCES

1. Poorman TL, Farrington FH, Mourino AP. Comparison of a chloral hydrate/hydroxyzine combination with and without meperidine in the sedation of pediatric dental patients. Pediatr Dent 1990; 12: 288-91.
2. Choi YS, Shim YS. Sedation practices in dental office: a survey of members of the korean academy of pediatric dentistry. J Korean Acad Pediatr Dent 1999; 26: 579-88.
3. An SY, Choi BJ, Kwak JY, Ka JW, Lee JH. A survey of sedation practices in the korean pediatric dental office. J Korean Acad Pediatr Dent 2005; 32: 444-53.
4. Bae CH, Kim H, Cho KA, Kim MS, Seo KS, Kim HJ. A survey of sedation practices in the korean dentistry. J Korean Dent Soc Anesthesiol 2014; 14: 29-39.
5. Yang Y, Shin T, Yoo S, Choi S, Kim J, Jeong T. Survey of sedation practices by pediatric dentists. J Korean Acad Pediatr Dent 2014; 41: 257-65.
6. Kim JB. Application of a pediatric advanced life support in the situation of a dental treatment. JKDA 2015; 53: 538-44.
7. Burnweit C, Diana-Zerpa JA, Nahmad MH, Lankau CA, Weinberger M, Malvezzi L, et al. Nitrous oxide analgesia for minor pediatric surgical procedures: an effective alternative to conscious sedation? J Pediatr Surg 2004; 39: 495-9.
8. Tobias JD. Applications of nitrous oxide for procedural sedation in the pediatric population. Pediatr Emerg Care 2013; 29: 245-65.

9. Houpt MI, Limb R, Livingston RL. Clinical effects of nitrous oxide conscious sedation in children. Pediatr Dent 2004; 26: 29-36.
10. Faddy SC, Garlick SR. A systematic review of the safety of analgesia with 50% nitrous oxide: can lay responders use analgesic gases in the prehospital setting? Emerg Med J 2005; 22: 901-8.
11. Sivaramakrishnan G, Sridharan K. Nitrous oxide and midazolam sedation: a systematic review and meta-analysis. Anesth Prog 2017; 64: 59-65.
12. Tak M, Kim J, Yang Y, Lee D. Trends in dental sedation of korean children and adolescents. J Korean Acad Pediatr Dent 2021; 48: 313-23.
13. Foley J. A prospective study of the use of nitrous oxide inhalation sedation for dental treatment in anxious children. Eur J Paediatr Dent 2005; 6: 121-8.
14. Song S, Han M, Kim J. Safety of chloral hydrate sedation in dental practice for children: An overview. J Dent Anesth Pain Med 2020; 20: 107-18.
15. Wilson S, Gosnell ES. Survey of american academy of pediatric dentistry on nitrous oxide and sedation: 20 years later. Pediatr Dent 2016; 38: 385-92.
16. Coté CJ, Notterman DA, Karl HW, Weinberg JA, McCloskey C. Adverse sedation events in pediatrics: a critical incident analysis of contributing factors. Pediatrics 2000; 105: 805-14.
17. Choi SJ, Park HW. Assessment of dental anxiety in the child patient by their drawings. J Korean Acad Pediatr Dent 2003; 30: 354-62.
18. Quinonez R, Santos RG, Boyar R, Cross H. Temperament and trait anxiety as predictors of child behavior prior to general anesthesia for dental surgery. Pediatr Dent 1997; 19: 427-31.