Original Article

# Risk Factors for Postoperative Nausea and Vomiting in Pediatric Patients Undergoing Ambulatory Dental Treatment

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**Abstract**

**Aim:** This study aimed to determine the risk factors for postoperative nausea and vomiting (PONV) in children receiving dental treatment under general anesthesia and to identify the subcategories leading to risk formation. **Materials and Methods:** The study comprised of 100 American Society of Anesthesiologists I patients aged 2–7 years who were administered dental treatment under general anesthesia. Patients were evaluated with regard to PONV risk. Eight different independent risk factors were identified as follows: age, gender, weight, duration of anesthesia, duration of recovery, postoperative pain, rescue analgesia, and type of dental treatment. Classification and regression trees method was used to choose the best predictor for PONV. **Results:** The incidence of PONV was 25%. No significant difference was found between those with PONV and those without PONV with regard to gender, weight, duration of anesthesia, duration of recovery, or the type of dental treatment ($P > 0.05$). However, postoperative pain level and use of rescue analgesia with tenoxicam were both predictors of PONV ($P < 0.05$). For the postoperative pain (≤1.5) subgroup, age proved to be the best predictive variable. **Conclusion:** The risk limit for PONV was determined to be ≥5.5 years for children who underwent dental procedures under general anesthesia. Postoperative pain and rescue analgesia constituted risks for PONV.

**Keywords:** *Children, postoperative nausea and vomiting, postoperative pain, risk factors*

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## Introduction

Postoperative nausea and vomiting (PONV), one of the most frequent adverse effects following general anesthesia, may cause patient discomfort, electrolyte abnormalities due to dehydration, aspiration pneumonia, and intracranial pressure elevation.[1] Moreover, unexpected hospitalization or prolonged recovery time induced by PONV may cause anxiety among patients. PONV has a multifactorial etiology including anesthetic (volatile agents, opioids, and nitrous oxide) patient-related (young age, female gender, obesity, history of PONV, motion sickness, nonsmoking, and surgical factors (strabismus surgery, laparoscopic surgery, ear and eye surgery, duration of surgery, etc.).

In adults, several risk scoring systems have been developed to assess the individual risk of PONV. Risk scoring systems provide anesthesiologists effective prevention of PONV by applying antiemetic strategies.[2-4] However, risk scores validated in adults are not applicable to children.[2] Thus, risk factors specific to the pediatric population are needed, and a risk model is required to facilitate the prediction of PONV in children. For example, nonsmoking and a history of PONV after previous anesthesia are known risk factors for PONV in adults. Thus, there is a need for a separate scoring system for children.[2,4] Currently, only a few studies have estimated the risk scores in children.[3,4]

Eberhart *et al*.[3] in their study suggested that the occurrence of postoperative vomiting (POV) in children

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can be predicted using a duration surgery longer than 30 min, age ≥3 years, strabismus surgery, and a previous history of POV in the children or relatives.[3]

Bourdaud *et al*.,[4] detected stratified age, predisposition to POV, duration of anesthesia, surgery at risk, and multiple opioid doses as specific pediatric risk factors for POV. They created a simplified score based on these risk factors to predict which children are at high risk of POV.[4]

No studies have evaluated the risks of PONV following various dental procedures performed under general anesthesia. Thus, studies are needed to accurately determine the risk factors for PONV, particularly after dental procedures in children. This study aimed to determine the risk factors for PONV in children receiving dental treatment under general anesthesia and to identify the subcategories leading to risk formation.

## Materials and Methods

This prospective observational study was approved by the Research Ethics Committee of Faculty of Medicine, Adnan Menderes University. Informed written consent was obtained from all patients' parents or caregivers, according to the ethical guidelines of the 2008 declaration of Helsinki.

The study comprised of 120 patients aged 2–7 years who were scheduled for dental treatment under general anesthesia due to the lack of chairside cooperation in our hospital between September 2016 and December 2016.

Patients who required preoperative antiemetic prophylaxis due to the severe potential consequences of vomiting were excluded from the study. Exclusion criteria were personal or family history of PONV, patients whose the American Society of Anesthesiologists classifications are not I, motion sickness, children who are at or above 95$^{th}$ percentile of weight, administration of any antiemetic in the perioperative and postoperative period due to the severe PONV, and the need for postoperative maintenance of tracheal intubation and/or sedation, guardian or parents do not have communication skills or/and unable to evaluate the presence of a postoperative discomfort.

Twenty patients were excluded from the study due to intra-operative antiemetic prevention ($n$ = 12) or due to missing data regarding vomiting issues ($n$ = 8). One hundred patients met the inclusion criteria. None of the patients received premedication; the standard anesthesia procedure (1% propofol 2 mg/kg, fentanyl 1 μg/kg, and rocuronium 0.5 mg/kg) was used for all patients. Anesthesia was maintained with 2% sevoflurane in a mixture of 50% oxygen and nitrous oxide. All patients received intravenous (IV) paracetamol 10 mg/kg for analgesia, 20 min before the end of surgery.

### Risk factors

For pediatric patients undergoing dental treatment under general anesthesia, eight different independent risk factors were identified as follows: age, gender, weight, duration of anesthesia, duration of recovery, postoperative pain, rescue analgesia, and type of dental treatment on the base of previous studies.[3,4]

The duration of anesthesia was defined as the period between initial induction and extubation. The Aldrete Scoring System is the most widely used tool to clinically evaluate the physical status of a patient recovering from general anesthesia. A score of 0–2 is given for each of the five categories (activity, circulation, consciousness, $O_2$ saturation, and respiration) for a maximum score of 10.

The duration of recovery was the period between when the patient was taken to the postanesthesia care unit (PACU) and the time the patient's Aldrete recovery score was ≥9. Patients were sent to the service after the recovery period.

The postoperative pain of the patients was evaluated at every 5 min in PACU and every 4 h during the first postoperative 24 h. Pain scores were based on the Wong-Baker FACES (WBF) pain scale.[5] Rescue analgesia was described as the use of tenoxicam (0.4 mg/kg), a nonsteroidal anti-inflammatory drug (NSAID), at every postoperative pain scoring when WBF pain scores were ≥2.[6] Dental procedures were of two major types as follows: endodontic and restorative, and restorative and extraction.

### Postoperative nausea and vomiting assessment

PONV was recognized when there was a recording that vomiting had occurred or that actions indicative of nausea, such as repeated gagging or spitting, were observed within 24 h following general anesthesia in the hospital and at home. All PONV episodes occurred during the first 24 h following anesthesia were noted. PONV was evaluated using a postoperative checksheet. Parents and/or guardians were informed about checksheets, how to evaluate the presence of PONV. In addition, the researchers let them know that they will call after the day patient was discharged, by telephone to report the presence of PONV. Patients who did not accept telephone calls and were not able to assess the presence of PONV were excluded from the study.

### Dental treatment procedure

All dental treatment procedures were performed by the same pediatric dentist. All restorative and pulpal treatments and tooth extractions were completed in a single session under general anesthesia. Pulpotomy and

pulpectomy applications were performed as endodontic procedures on primary molars. Tooth extractions were performed before extubation.

### Statistical analysis

The Kolmogorov–Smirnov test was used to assess the normality of numeric variables. For the normally distributed numeric variables, the comparison between groups was made by independent sample *t*-test, and descriptive statistics are presented as mean ± standard deviation. For the numeric variables that were not normally distributed, the comparison between two groups was made using the Mann–Whitney U-test, and descriptive statistics are presented as medians ($25^{th}$–$75^{th}$ percentiles). To analyze the categorical data, a Chi-squared test was used, and descriptive statistics are presented as frequency (%). All the values of $P < 0.05$ were considered as statistically significant.

In this study, we used the classification and regression tree (C and RT) software to develop models that can classify subjects into different risk categories.[7] Recursive partitioning a nonparametric statistical method for multivariable data uses a series of dichotomous splits (e.g., the presence or absence of symptoms and other demographic variables) to create a decision tree with the goal of correctly classifying members of the population by choosing the best predictor. The best predictor is chosen using a variety of impurity or diversity measures. The goal is to produce subsets of the data which are as homogeneous as possible with respect to the target variable.[8] The C and RT not only determine the association between the dependent variable and the independent variable but also explore the interactions among the independent variables.

## Results

The incidence of PONV was 25%. No significant difference was found between those with PONV and those without PONV with regard to gender, weight, duration of anesthesia, duration of recovery, or the type of dental treatment ($P > 0.05$) [Table 1]. However, there were statistically significant differences between the two groups regarding postoperative pain level and rescue analgesia ($P < 0.05$).

The decision rules of C and RT provide specific information about risk factors based on the rule induction. The C and RT have 4 leaf nodes, of which three are terminal nodes. The variables were postoperative pain (importance value = 0.025) and age (importance value = 0.017). The postoperative pain was the most important determining factor for PONV. This first-level split produced the two initial branches of the decision tree. There was no predictive variable for the postoperative pain score >1.5 subgroup, and hence that became the terminal node. For the postoperative pain (≤1.5) subgroup, age proved to be the best predictive variable; age (≤5.5) vs. >5.5). There was no predictive variable for the age subgroup [Figure 1].

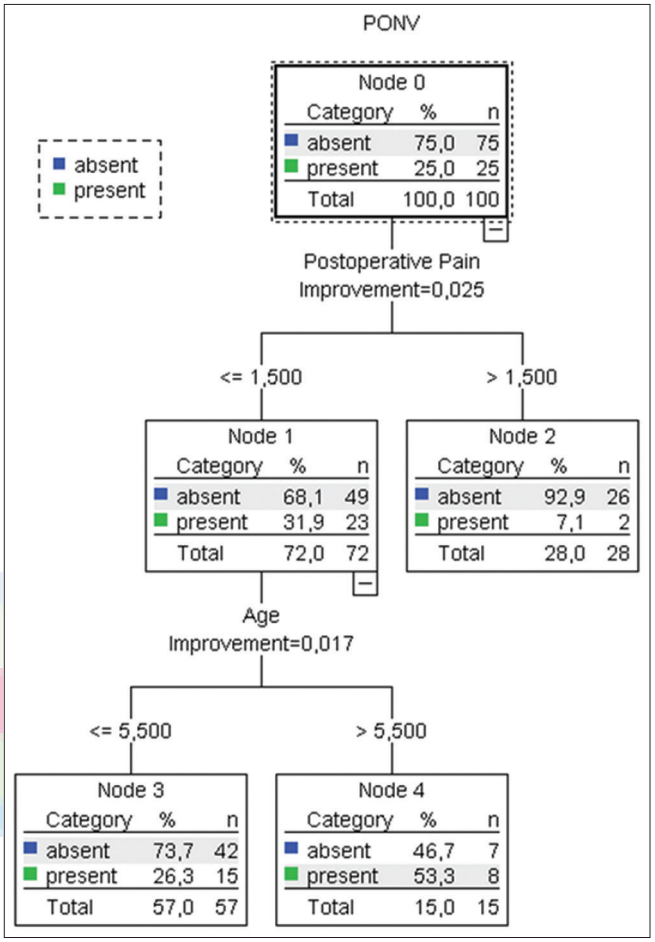


**Figure 1:** Decision tree by classification and regression trees algorithm

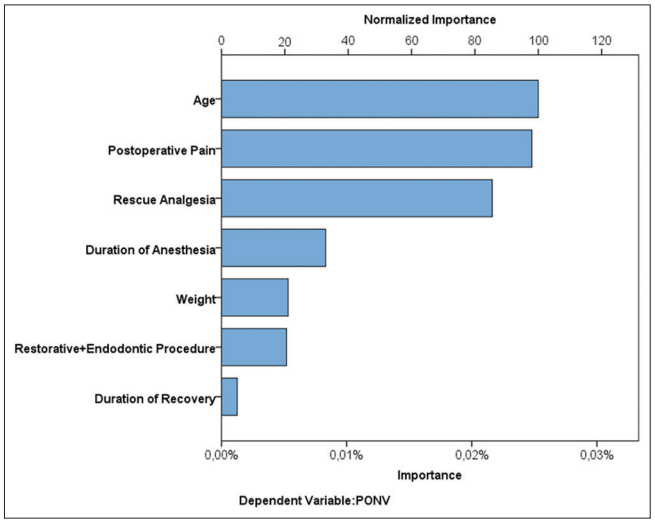


**Figure 2:** Importance values of independent variables in the postoperative nausea and vomiting decision tree

**Table 1: Patient characteristics and univariate analyses of postoperative nausea and vomiting risk factors**

| | PONV (-) (*n*=75) | PONV (+) (*n*=25) | *P* |
|---|---|---|---|
| Age (years) | 4.2±1.6 | 4.9±1.9 | 0.211 |
| Gender (female/male) | 28/47 | 12/13 | 0.357 |
| Weight (kg) | 17.2±4.4 | 19.0±8.4 | 0.417 |
| Postoperative pain | 1 (1-4) | 1 (1-1) | 0.008* |
| Rescue analgesia (+/−) | 24/51 | 2/23 | 0.033* |
| Duration of anesthesia (min) | 50.0 (37.0-68.0) | 45.0 (38.0-60.0) | 0.372 |
| Duration of recovery (min) | 15.0 (15.0-15.0) | 15.0 (10.0-17.5) | 0.612 |
| Type of dental treatment | | | |
| Restorative and endodontic procedure (+/−) | 53/22 | 17/8 | 0.805 |
| Restorative and extraction procedure (+/−) | 51/24 | 18/7 | 0.806 |

*Significant difference between results ($P$<0.05). Data are mean±SD, number of cases, or median ($25^{th}$-$75^{th}$ percentile). PONV=Postoperative nausea and vomiting; SD=Standard deviation; (+)=present; (-)=absent

We report the importance values for predictors in Figure 2. From the plot, we found that the three prognostic factors (age, postoperative pain, and rescue analgesia) had effects on PONV [Figure 2]. At the end of C and RT, the sensitivity, the specificity, and the accuracy were determined to be 90.7%, 32%, and 76%, respectively.

## Discussion

In this prospective study, we identified three independent risk factors for PONV in children including rescue analgesia, postoperative pain and age. We found the overall PONV incidence to be 25%, similar to those of other studies examining PONV in pediatric patients.[4] While Bourdaud *et al*.[4] found the PONV incidence to be 24.1% (similar to our result), Yumura *et al*.[9] determined the same incidence in children younger than 13-year-old to be 12.7%. The differences seen in the PONV incidences in these studies may be due to the various age groups.

The PONV risk in children does not follow a linear course.[4,10] While the PONV risk is low in children whose ages are under 3 years, it increases during the 6–13 age range and before puberty.[11,12] In this study, eight independent risk factors for PONV were evaluated in children who underwent full mouth dental rehabilitation under general anesthesia: age, gender, weight, duration of anesthesia, duration of recovery, rescue analgesia, postoperative pain, and type of dental treatment. Of these risk factors, use of rescue analgesia and level of postoperative pain were determined to be effective predictors of PONV in children. The children's pain was evaluated in the PACU, and those whose pain score was over 2 were administered tenoxicam. According to C and RT analysis, a definite decrease in the PONV risk was seen in those whose postoperative pain score was over 1.5. Those patients requiring rescue analgesic was administered an NSAID (tenoxicam). Essentially while high pain scores are expected to increase the PONV risk, in this study, the PONV risk was high in low pain scores, contrary to expectations. The reason for this could have been the use of tenoxicam, an NSAID, instead of an opioid.[13,14] Opioids, which are frequently preferred for postoperative pain, increase the PONV risk and constitute one of the primary risk factors in risk scoring systems.[15,16] Bourdaud *et al*.[4] evaluated the effect of analgesics used during the postoperative period on PONV, and proved that paracetamol did not increase PONV risk and that the opioid derivatives increased PONV risk. However, they added that NSAIDs did not have an effect on PONV.[4] Even though, we did not use opioids in our study, we are of the opinion that tenoxicam had a reducing effect on PONV risk. It would be useful to compare the influences of NSAIDs on PONV in future studies.

C and RT method provided us to notice that the age was important and a good predictor for PONV in children who had low postoperative pain. In most studies, the risk factor for PONV was reported to be age ≥3 years.[3,10] However, we found the PONV risk factor to be age >5.5 years. Bourdaud *et al*.[4] could not estimate a linear relationship between age and PONV risk. For this reason, when they grouped the children and re-evaluated, they showed that PONV risk in children who were between 6 and 13 years was twice that of children aged 3 to 6 or over the age of 13.

Female gender is accepted as a risk factor for PONV in adults from puberty.[14] The female gender is the main risk factor in Simplified Apfel and Koivuranta Scoring Systems widely used in adults.[15] However, gender does not have an effect on PONV in patients younger than 13.[4] We also did not find any effects of gender on PONV in children in our study.

While obesity and overweight are as general risk factors, Yumura *et al*.[9] indicated lower weight among the major

risk factors.[15] These results could have been influenced by the age factor. Body weight could be reasoned to be related with age. The study comprised of children with normal weights for their ages. For this reason, the weight may not have been found related to PONV.

Only a limited number of procedure types that cause PONV in children have been studied. For patients of all ages, intra-abdominal, laparoscopic, orthopedic, gynecological, otolaryngologic, thyroid, breast, plastic, and neurosurgical procedures increase PONV risk.[15] While Eberhart *et al*.[2] estimated only the strabismus surgery in children as an independent risk factor, Bourdaud *et al*.[4] added tympanoplasty and tonsillectomy into the group of surgery types likely to cause PONV in children.[3] The dental procedures conducted under general anesthesia in the patient population in our study are minor intraoral surgical applications that could lead to postoperative pain and PONV.[16] We examined these dental procedures by grouping them as restorative and endodontic, and restorative and extraction procedures. However, we did not determine a significant correlation between PONV risk and procedure type.

Operations lasting over 30 min and the anesthesia periods over 45 min have been accepted as risk factors in scoring PONV risks in children.[3,4] Unlike the previous studies, we determined that anesthesia duration had no effect on the PONV risk in children. The most significant reason for this finding could be that we created a standard anesthesia protocol and did not use opioids except as induction drugs. Use of opioids becomes a risk factor for PONV when opioids are administrated again during the surgery or in the postoperative period.[13]

The type of anesthetic used does not have any effect on PONV in children, unlike in adults, and there has been no relation seen between nitrous oxide and PONV.[4,17] However, propofol usage may diminish PONV risk.[9] In the standard anesthesia protocol followed in our study, sevoflurane, a volatile anesthetic, was preferred and opioid use was restricted. While the effect of the anesthesia period on PONV risk is being studied, it will be more accurate to evaluate volatile and IV anesthetic procedures by separating them from each other.

For the convenience of clinical application, it is important to define the risks accurately and to decrease the number of the risks to be evaluated. A scoring system to be used to predict the PONV frequency in children should be easy to use to ensure widespread clinical acceptance. There should be few factors, as in the risk models created for adults.[18] Koivuranta *et al*.,[19] who used this approach for adults, observed that there was no difference in the determination of PONV risk when they diminished factors from 10 to 5.

There is a correlation between the duration of recovery and PONV.[20] In our study, duration of recovery was not a risk factor for children who underwent various dental treatments.

## Conclusion

Within the limitations of this study, the risk limit for PONV was determined to be ≥5.5 years for children who underwent dental treatment under general anesthesia. Postoperative pain and rescue analgesia constituted risks for PONV. The administration of the NSAID (tenoxicam) as a rescue analgesic, rather than opioid, to children experiencing postoperative pain had a decreasing effect on PONV risk. Duration of anesthesia, duration of recovery, dental treatment type, gender, and weight had no effect on PONV risk.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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