



Scientific Article

Postoperative Pain and Other Sequelae of Dental Rehabilitations Performed on Children Under General Anesthesia

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Abstract: Purpose: The purpose of this study was to determine the prevalence, severity and variables influencing postoperative pain and other sequelae in children undergoing dental rehabilitation under general anesthesia. **Methods:** Healthy children scheduled for dental rehabilitation having treatment on only primary teeth were included in the study. General anesthesia protocol was standardized, and patients did not receive local anesthesia intraoperatively. Pain and other postoperative sequelae were recorded for 7 days postoperatively. **Results:** Ninety-five percent of the 90 children had postoperative pain which was moderate in intensity and highest immediately postoperatively. Children who had extractions or were at least 4 years old and had more than 12 procedures experienced increased postoperative pain. The most common postoperative symptoms other than pain were agitation, need for analgesics, and sleepiness. Longer operative times resulted in increased postoperative sleepiness. Children whose tracheal intubations were traumatic were more likely to report sore throats. Children who were at least 4 years old required more analgesics, experienced more postoperative sleepiness, and had nausea more frequently. All postoperative problems significantly decreased by postoperative day 2 and ceased by postoperative day 4 to 5. **Conclusion:** Children undergoing dental rehabilitations under general anesthesia commonly experience postoperative symptoms such as pain, agitation, need for analgesics, and sleepiness. (*Pediatr Dent* 2008;30:111-21) Received February 19, 2007 / Last Revision May 31, 2007 / Revision Accepted June 10, 2007.

KEYWORDS: DENTAL REHABILITATION, POSTOPERATIVE, PAIN, CHILDREN, GENERAL ANESTHESIA

For most children, dental treatment can be completed in the normal dental setting using any of a number of behavior management techniques. For a minority of children, however, special behavior management methods, including general anesthesia (GA), may be required to provide optimal dental treatment. Such groups include children with extreme anxiety, extensive treatment needs, very young age, and/or physical/mental disabilities. The advantage of treatment under GA is that all necessary treatment can be completed during a single visit and under minimal duress to the patient, parent, and dentist. GA is often considered the treatment of last resort due to its expense, risk-benefit considerations, and acceptability to

parents. For GA to be an acceptable option, care during and after surgery must be of the highest quality and postoperative morbidity must be minimized.

Dentists usually have limited contact with parents after dental rehabilitation under GA and, therefore, are not able to precisely determine how children recover and whether they suffer from any postoperative symptoms during this critical period. Dentists performing this procedure need to know how to advise parents about what to expect immediately postoperatively and during the ensuing days. Every effort must be made to ensure that the patient remains as comfortable as possible and that morbidity is minimized.

A body of literature exists that describes the recovery period of children who have undergone GA for dental restorative procedures and/or simple extractions.¹⁻¹¹ Many of these studies demonstrate conflicting results. While some studies have shown the prevalence of postoperative morbidity to be significant,^{2,3,7,9-11} others have found it to be minimal.^{1,4,5,6,8} It is difficult to compare these studies, since they vary considerably regarding: (1) use of reliable and validated pain scales; (2) use of comparative statistics to evaluate potentially relevant variables such as age, gender, and socioeconomic status (SES); (3) number and types of procedures performed; (4) length of the procedure; (5) outcomes measured and for what length of time; (6) medical and cognitive status of the subjects; (7) standardization of the local and GA used

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intraoperatively; and (8) use of post-operative analgesics.

To manage pain and other sequelae appropriately in children, it is important to anticipate their occurrence. Without adequate assessment of these occurrences in children undergoing GA, it is difficult to plan appropriate interventions, take steps to ensure their effectiveness, and prevent over- or undermedication during recovery. Parents need to know how to manage these occurrences once they return home. A better understanding of these matters will lead to improved pain management techniques in children, thus reducing the children's postoperative emotional and physical distress.

The purposes of this study were to:

1. improve upon the limitations of the previously cited studies of postoperative sequelae of children undergoing general anesthesia for dental procedures; and
2. determine:
 - a. the prevalence and severity of postoperative pain in children undergoing dental rehabilitation under GA;
 - b. the prevalence of other postoperative sequelae, such as nausea/vomiting, drowsiness, fever, agitation, and insomnia; and
 - c. whether age, gender, socioeconomic status, race, traumatic nasotracheal intubation, and types and number of dental procedures influence the intensity and duration of postoperative pain and other sequelae.

Methods

Subjects. Children who were scheduled for dental treatment under GA in the operating room at Children's Hospital, Boston (CHB), Mass, were eligible to participate in this institutionally-approved study if they: (1) were healthy (American Society of Anesthesiologists status 1); (2) were 12 years old or younger; and (3) had parents fluent in English. All children were seen preoperatively in the Department of Dentistry at CHB. Children who were scheduled for the operating room had one or a combination of the following characteristics: young age, uncooperative behavior, significant dental caries, and/or psychological problems.

Children who were identified as candidates to receive dental treatment under GA were approached by a dentist member of the CHB Department of Dentistry staff for participation in the study.

	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back and forth, tense	Arched, rigid, or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint	Crying steadily, screams or sobs, frequent complaints
Consolability	Content, relaxed	Reassured by occasional touching, hugging, or being talked to, distractible	Difficult to console or comfort

The study was explained in detail, including all principal and germane risks involved. If the parent was interested in participating, verbal and written consent was obtained. Patients underwent dental rehabilitation regardless of participating in the study.

Pain scales. The face, legs, activity, cry, consolability (FLACC) pain assessment tool was the primary instrument used by the post anesthesia care unit (PACU) nurses and parents to assess the prevalence and intensity of the child's pain in this study. The FLACC pain assessment tool incorporates 5 categories of pain behaviors: (1) facial expression; (2) leg movement; (3) activity; (4) crying; and (5) consolability. Each category is scored from 0 to 2, resulting in a total score between 0 and 10 (Table 1). The FLACC score has been validated for assessment of postoperative pain in children between the ages of 2 months and 7 years.¹² The FLACC scale has been shown to be reliable and valid for measuring postoperative pain in children with mild to severe cognitive impairment.¹³ In this study, the FLACC score was used for children of all ages.

In addition to the FLACC, pain was also assessed using the Wong-Baker Faces Pain Rating Scale.¹⁴ The scale is a self-report rating system used to assess the intensity of children's pain and consists of a card with 6 faces with different emotions ranging from the least to the most pain (Figure 1). Although it is a self-report measure of pain, in this study the parents used this scale, not the children themselves, to rate their child's postoperative pain. As such, the Wong-Baker Faces Scale was used as an observer-based, exploratory, collaborative methodology.

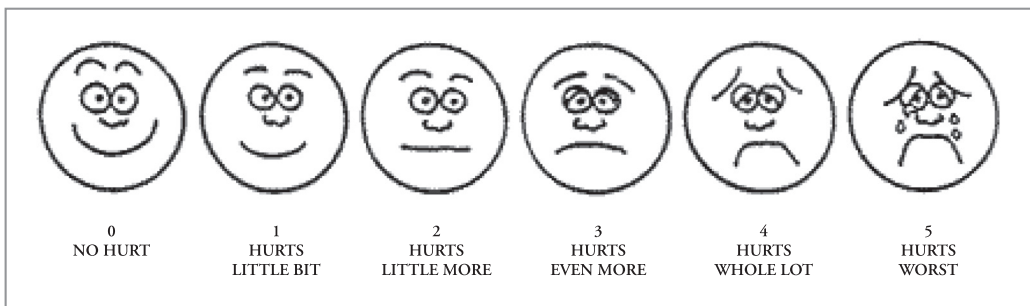


Figure 1. Wong Baker Faces Pain Scale

Anesthesia. The GA protocol was standardized to ensure that this was not a confounding variable in the study. If the patient needed a preoperative sedative medication, midazolam was used on a case-by-case basis. All children were intubated with a nasotracheal tube. An intubation was considered to be traumatic if there was more than minimal bleeding and if more than one attempt at intubation was required. For maintenance of anesthesia, a combination of sevoflurane, nitrous oxide, and propofol was used. Every patient's throat was packed with gauze prior to surgery. Intraoral local anesthesia was not administered to any patient during the dental rehabilitation. If the child exhibited emergence agitation following surgery, the anesthesiologist administered 1 mcg/kg of intravenous fentanyl. After completion of the surgery, children were transferred to the PACU where they remained until discharge.

Recovery. After the dental rehabilitation was completed, the dentist spoke with the parents regarding the procedures performed and gave them standardized postoperative instructions. Patients were instructed to adhere to a soft diet with adequate fluid intake for 2-3 days postoperatively. If their child was in pain or discomfort, parents were advised to give either ibuprofen or acetaminophen dosed according to the manufacturer's guidelines. If extractions were performed, parents were advised regarding hemostasis and wound care. The parents were then escorted to the PACU, where they stayed with their child throughout the rest of the immediate recovery period. All children were discharged from the PACU on the day of the dental rehabilitation.

Follow-up. Parents were called on the first 2 postoperative evenings to ensure that all their questions were answered and that they were filling out the questionnaire correctly. Parents were told to contact either of 2 authors of this study at any time if they had questions about the study, recovery process, or dental rehabilitation. As per the Department of Dentistry's guidelines, the child was seen at the dental clinic 1 week postoperatively for a follow-up visit. At this visit, an intraoral examination was completed to ensure adequate healing and recovery from the dental procedures, intact restorations, and adequate oral hygiene. In addition, the parental questions were answered and the study questionnaire was collected.

Data collection. Data were gathered from questionnaires completed by the: (1) parents both preoperatively and postoperatively for 7 days; (2) anesthesiologist performing the general anesthetic; (3) PACU nurse attending to the patient during the immediate postoperative period; and (4) dentist performing the procedure.

The parental questionnaire collected information on demographics, the child's preoperative history of oral pain, and a record of pain and postoperative sequelae. The parents were instructed in how to use the 2 pain scales, and the questionnaire was thoroughly reviewed. In the preoperative holding area,

parents were asked to record their child's preoperative pain level using the 2 pain scales. Following surgery, parents were asked to record pain using the 2 pain scales and any postoperative symptoms every 3 hours for the first postoperative day and then 3 times daily until their follow-up 1 week later.

The anesthesiologist's questionnaire recorded the use and type of premedication, method and quality of tracheal intubation, dosage/timing of anesthetic, and procedure length. All anesthesiologists followed the standardized GA protocol and did not use any intraoperative opiates.

The PACU nurse questionnaire recorded symptoms during the course of the recovery prior to discharge. Analgesics were administered at the discretion of the bedside nurse in accordance with physician orders. All bedside PACU nurses were experienced in scoring pain with the FLACC pain assessment tool, as well as the Wong-Baker faces scale. Other postoperative side effects and complaints, which included pain, agitation, vomiting, and bleeding, were recorded throughout the course of recovery. The nurses also recorded use of analgesics administered and the duration of recovery.

The dentist's questionnaire included data on the types of procedures performed on each tooth. Subjects were divided into 4 groups according to the most "invasive" procedure performed during the rehabilitation. Extractions were considered the most invasive followed by pulpotomies, stainless steel crowns (SSCs), and amalgam or resin restorations. The dentists who provided care to these patients were limited to 9 dental residents supervised by the senior dental staff members of the CHB's Department of Dentistry.

Statistical analyses. We evaluated both the Wong-Baker faces scale and the FLACC pain scale scales at 4 time periods: (1) preoperatively (preop)—by the parent while the patient was waiting in the preoperative holding area prior to the dental rehabilitation; (2) PACU—by the attending nurse during the patient's recovery in the PACU; (3) first home—by the parent immediately after arriving home; and (4) highest home—the highest pain score recorded by the parent at home during the 1-week postoperative period.

The correlation between the Wong-Baker faces scale and the FLACC pain scale scales measured at each of these 4 times was evaluated with Spearman's correlation coefficient. Relationships between pairs of categorical variables were examined in tables and evaluated using Fisher's exact test. When one variable was continuous and the other categorical, the medians of the continuous variable in the levels of the categorical variables were compared using the Wilcoxon rank-sum test. Multivariate logistic regression was used to evaluate the relationship between the child's age, the most "invasive" dental procedure, and the number of procedures and FLACC scores of 6 or more. Since this is a very small study, we present *P*-values, some very small and others not, so the reader can get a sense of the magnitude of associations. With just 90 subjects, we feel that *P*-values below approximately .20 suggesting

interesting relationships and that strictly adhering to the .05 level of statistical significance is not meaningful. All *P*-values are 2-sided.

Results

Ninety-seven children having dental rehabilitation under GA who met the study criteria were enrolled in the study. Ninety of the 97 children had either restorative treatment or extractions performed on only primary teeth during the procedure. The 7 subjects who had treatment on some permanent teeth were excluded, leaving 90 subjects for data analysis.

The median age of the study sample was 4 years (range=2-10); 66% of the subjects were female. The patient mix was Hispanic (36%), Caucasian (31%), African American (25%), and other (8%). Sixty percent of the fathers and 52% of the mothers had more than a high school education. The median operative time was 90 minutes (range=30-185 minutes).

Types and quantity of dental procedures. Nine hundred and two dental procedures were performed on primary teeth. The most common procedure performed was an amalgam or resin restoration (35%), followed by SSC (28%), extraction (28%), and pulpotomy (9%). On average, each of the dental rehabilitations consisted of 4 amalgam/resin restorations, 2 SSCs, 3 extractions, and 1 pulpotomy. Sixty-four percent of subjects had at least one extraction as the most invasive dental procedure, followed by 28% with SSCs, 7% with amalgam or resin restorations, and 1% with pulpotomies.

Pain scales. The pain scores from the Wong-Baker faces scale and the FLACC pain scale were highly correlated at each of the 4 time periods (*P*<.001), therefore all further data analyses used only the FLACC pain scale.

Postoperative pain. Pain was the most common postoperative symptom reported, with 95% of children reporting pain. Pain scores were moderate in intensity (median FLACC pain score=5) and were highest immediately postoperatively in the PACU. Figure 2 illustrates that the median reported pain scores decreased steadily as time progressed until there was no pain by postoperative day 5. The number of children having a specific FLACC score is represented by the grouping of data points at each time period. There was a tendency for reporting higher pain scores at the first home (*P*=.18) and highest home (*P*=.13) as the number of dental procedures performed during the rehabilitation increased. These differences, however, did not reach nominal statistical significance. Children who were at least 4 years old were more likely to experience pain, as indicated by FLACC scores of 6 or greater at the first report at home and at the highest pain score during the recovery period (*P*=.01; Table 2).

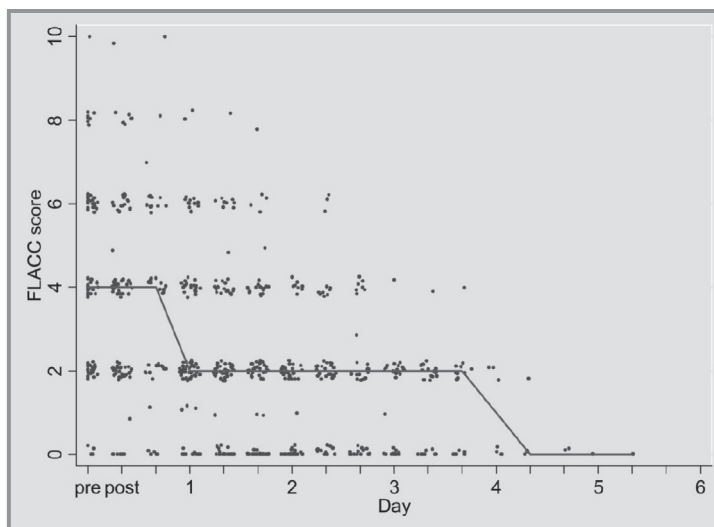


Figure 2. Post-operative pain over the 1st post-operative week

Table 2. PERCENT OF OLDER AND YOUNGER CHILDREN WHO REPORTED PAIN (FLACC* SCORE OF 6 OR GREATER) AT EACH OF 4 TIME POINTS

Time periods	Age (ys)		<i>P</i> -value [†]
	≥4	<4	
Preoperatively	33	37	.43
Post anesthesia care unit (PACU)	50	47	.49
First home	54	18	.01
Highest home	56	26	.01

* FLACC – Faces, Legs, Activity, Cry, Consolability Pain Assessment Tool

† Fisher's exact test

Extractions were also significantly related to the intensity of reported pain (*P*=.01; Table 3). Those children who had extractions as part of their dental rehabilitation were more likely to experience pain, as reported by FLACC scores of 6 or greater at 3 of the 4 measurement time periods: (1) preop (*P*=.01); (2) first home (*P*=.01); and (3) highest home (*P*=.01) during the first week postoperatively. Children having extractions, however, were not more likely to experience pain, as reported by FLACC scores of 6 or greater in the PACU (*P*=.31). Seven of the 90 children received intraoperative fentanyl due to emergence agitation. Eliminating these 7 children from the analysis lowered the *P*-value to .17 when comparing the PACU pain for those children having extractions to those who did not, but still did not reach nominal statistical significance.

Children having a traumatic intubation tended to experience more pain in the PACU as reported by FLACC scores of 6 or greater than those not having a traumatic intubation (*P*=.07).

There was no association between traumatic intubation and pain at the first home ($P=.51$) or highest home ($P=.39$) reports of pain.

There was no relationship between reported pain (FLACC scores of 6 or greater) and gender or ethnicity at any of the 4 time periods analyzed. There was an association between reports of greater pain (FLACC scores of 6 or greater) and parents with less education. Children of mothers with less education reported greater pain in the preop period ($P=.12$) as did children of fathers with less education in both the preop ($P=.08$) and PACU periods ($P=.04$).

Table 3. PERCENT OF CHILDREN WITH AND WITHOUT EXTRACTIONS WHO REPORTED PAIN (FLACC* SCORE OF 6 OR GREATER) AT EACH OF 4 TIME POINTS

Time periods	Extraction		P-value†
	Yes	No	
Preoperatively	48	9	.01
Post anesthesia care unit (PACU)	52	44	.31
First home	52	16	.01
Highest home	59	16	.01

* FLACC – Faces, Legs, Activity, Cry, Consolability Pain Assessment Tool

† Fisher's exact test

Multivariate analyses of reported pain. The multivariate logistic regression revealed that children had higher first home FLACC scores if they: (1) were at least 4 years of age (6.6 times, $P=.001$); (2) had an extraction as the “most invasive” procedure (5.1 times, $P=.007$); or (3) had 12 or more procedures (2.5 times, $P=.09$; Table 4).

Table 4. ODDS RATIOS (95% CONFIDENCE INTERVAL) FOR PAIN (FLACC* SCORE OF 6 OR GREATER) ON THE FIRST HOME MEASUREMENT ASSOCIATED WITH THE CHILD BEING 4 OR MORE YEARS OF AGE, HAVING AN EXTRACTION, AND HAVING 12 OR MORE PROCEDURES

Model	Factor	OR (95% CI)	P-value
Main effects	≥4 ys old	6.6 (2.2, 20)	.001
	Extractions	5.1 (1.6, 17)	.007
	≥12 procedures	2.5 (0.9, 7.5)	.09
With interaction	≥4 ys old	3.4 (0.9, 13)	.07
	Extractions	5.1 (1.6, 17)	.007
	≥12 procedures	0.9 (0.2, 5.3)	.95
	≥4 ys old ≥12 procedures	5.3 (0.5, 51)	.15

* FLACC – Faces, Legs, Activity, Cry, Consolability Pain Assessment Tool

When an interaction term (age of 4 and older as well as 12 or more procedures) was added, older children with more procedures were 5.3 times ($P=.15$) more likely to have higher first home FLACC scores. Adding this extra term led to a reduction in the odds ratio and a loss of statistical significance for 2 of the main effects: (1) age of 4 or more years ($P=.07$); and (2) 12 or more procedures ($P=.95$). This model, however, better describes the relationships. Older children having 12 or more procedures demonstrate twice the rate of elevated first home FLACC scores (82% vs 40%) compared with the younger children where the rates were similar (21% vs 17%). Essentially, the same relationships were found when the outcome was the highest home measurements of the FLACC score. The interaction terms did not reach statistical significance, but this is a small sample, and the magnitude of the interaction odds ratios and the corresponding reduction in the main effects odds ratios suggest that there is interaction.

Other postoperative sequelae. Figure 3 illustrates the reported symptoms other than pain during the child's postoperative course at home (pain medication given, sleepiness, sleeplessness, agitation, sore throat, nausea, and fever). Most symptoms significantly decreased by postoperative day 2 and essentially ceased by postoperative day 4. Agitation (76%), need for postop medication (68%), and postoperative sleepiness (43%) were the most frequently occurring postoperative sequelae, other than pain. By postoperative day 2, reports of agitation ceased. By postoperative day 3, only 12% of the children were reported as needing analgesics. By postoperative day 5, all children discontinued the use of analgesics. Fewer than 11% of children felt sleepy after the first day of recovery. All other symptoms were reported less frequently: sore throat (27%), nausea (26%), problem falling asleep (22%), and fever (10%). The prevalence of these symptoms decreased to less than 10% by postoperative day 2, and all postoperative symptoms ceased after postoperative day 4.

An increase in the length of the dental rehabilitation resulted in more sleepiness ($P=.03$) and nausea ($P=.06$), but not having a sore throat ($P=.5$). Patients having a traumatic intubation were more likely to experience a sore throat ($P=.02$).

When compared with children younger than 4 years old, children who were at least 4 years old were more likely to experience postoperative nausea ($P=.01$), take medication at home ($P=.03$), experience sleepiness ($P=.03$), receive pain medication ($P=.03$), experience agitation ($P=.11$), and have a sore throat ($P=.12$; Table 5). When compared with males, females tended to experience more sleepiness ($P=.17$) and receive more medication at home ($P=.21$).

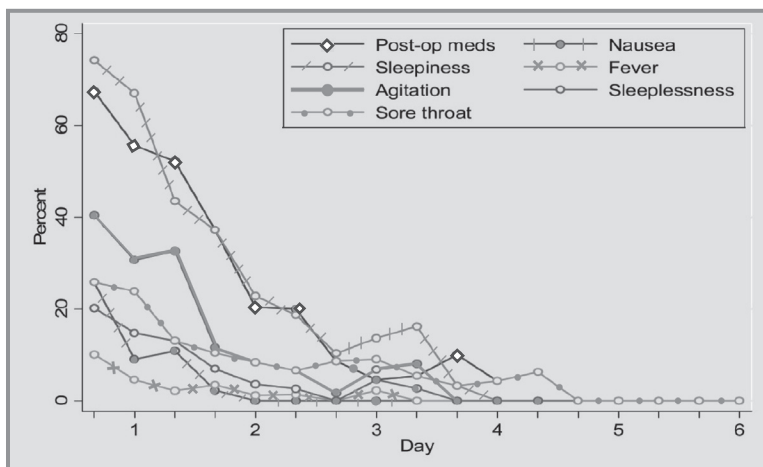


Figure 3. Symptoms over the 1st post-operative week

Table 5. PERCENT OF OLDER AND YOUNGER CHILDREN WHO HAD SPECIFIC POSTOPERATIVE SEQUELAE

Postoperative sequelae	Age (ys)		P-value†
	≥4	<4	
Post anesthesia care unit (PACU) medications	10	8	.54
Medications at home	83	63	.03
Nausea	37	11	.01
Sleepiness	69	47	.03
Fever	17	13	.41
Agitation	90	79	.11
Sleeplessness	35	34	.58
Sore throat	35	21	.12

* Fisher's exact test

Discussion

This study attempted to be a comprehensive evaluation of all postoperative sequelae of dental rehabilitations for children and improve upon the limitations of the previous studies. Table 6 compares the subjects, procedures, length of cases, and outcomes of our study with 11 other similar reports published between 1985 and 2006. It is useful when comparing our findings to other similar studies to note important differences between them. These include subject mean age and medical status, numbers and type of procedures performed (e.g., extractions only, restorative only, or both), reported outcomes, method used to obtain data (dichotomous or scaled questionnaires), and statistical analyses performed. Only 5 of these studies used statistical analyses beyond descriptive statistics to evaluate their outcomes.^{3,4,9-11}

Pain scales. Since pain is a subjective phenomenon that varies from person to person, the gold standard for pain assessment is self-report of pain.^{14,15} Assessment and measurement of

pain can be problematic in children compared with adults because of their lower level of verbal fluency and the likelihood that varied developmental levels alter their understanding of questions or tests and the ways in which pain is expressed. As such, children may be unable to communicate important medical information that may go unrecognized, such as pain, general distress, "unwellness," or nausea.

The primary purpose of this study was to measure the child's pain postoperatively. This study used both the Wong Baker faces pain rating scale and the FLACC pain assessment tool. The former has been validated for pediatric patients between 2 to 12 years of age and for parents reporting their child's pain.¹⁶ Young infants produce a consistent pattern of facial response to pain. Facial expression may be the most consistent infant indicator of pain.¹⁷

For children who are too young to properly use a pain rating scale using faces or are unable to express themselves, such as those with cognitive impairment, observational scales are the only method of assessment. Studies have shown that crying, body posture, and mobility are valid indicators of whether a child is in pain.¹⁸ Behavioral cues remain the primary indicators of pain in children who are unable to use a self-report scale. The FLACC scale has been shown to have excellent validity and reliability for pain assessment in young, cognitively intact children.¹⁸ Not only is the FLACC scale useful in this population, but is also useful to facilitate the objective measurement of pain in patients with cognitive impairment.^{17,19-21} According to these studies, patients with cognitive impairment exhibit more behavioral indicators of pain than those who are cognitively intact.

Although the Wong Baker faces pain scale and the FLACC pain scale differ in the variables used to indicate pain, the results of the present study indicate a high correlation between the 2 scales. Although both pain scales are highly valid, in the final analyses only the FLACC pain scale was used because the scores were based on a variety of pain indicators, which provided a broader measurement of the pain experience and are observer-based.

Self-report is the best measure of pain. To make an accurate assessment of pain based on observed behaviors, it is extremely important to consider the child's circumstances and environment at the time of assessment. For instance, crying and body movement may be responses to hunger, anxiety, and/or general distress and are not necessarily indicators of pain.¹² It has been reported that parents, especially mothers, can be relied upon to make an objective assessment of their child's anxiety.¹¹ Nonetheless, the parent's own anxiety level might bias them against accurately reporting their child's pain. Parents may rate the child's pain level higher than the child might rate themselves, probably attributable to their own fears and anticipation of the procedure. The present study, however,

Table 6. STUDIES OF POSTOPERATIVE SEQUELAE IN CHILDREN HAVING DENTAL PROCEDURES UNDER GENERAL ANESTHESIA

First author Year published	Present study	Enger ¹ 1985	Holt ² 1991	Fung ³ 1993	Noble ⁴ 1994	Enever ⁵ 2000	Vinckier ⁶ 2001	Chelliah ⁷ 2002	Prabhu ⁸ 2003	Atan ⁹ 2004	Ersin ¹⁰ 2005	Hosey ¹¹ 2006
Subjects												
N	90	200	103	40	100	55	98	87	100	121	86	407
Age (ys)												
(mean/median)	4	8	9	9	7	11	5	?	13	11	11	7
Range	2-10	1-52	5-13	6-13	3-14	3-17	2-6	2-11	3-31	6-16	6-16	2-15
American Society of Anesthesiologists status	1	≥1	≥1	1	NA	≥1	1	1-3	≥1	1-2	1-4	?
Procedures (mean)												
Extractions	3	5	2	Yes	3	Yes	2	6	Yes	4	Yes	Yes
Restorations	6	3	2	No		Yes	7	No	Yes	<1	Yes	No
Time (mins)	90	194	32	?	<10	?	90	?	69	54	102	?
Local anesthesia						50%						
% with outcome												
Pain/distress	95	?	51	93	36	16	0	53	8	74	45	77
Method	FLACC*	DQ [†]	DQ [†]	VAS [‡]	SQ [§]	DQ [†]	DQ [†]	DQ [†]	DQ [†]	VAS [‡]	VAS [‡]	SQ [§]
Time period	RR -day 7	RR	RR first home	24 hrs	RR	RR +?	RR	24 hrs	48 hrs	6 dys	24 hrs	7 dys
Agitation	76										26	
Postop medication	68											28
Sleepiness	43		45			13				84		48
Sore throat	27	4	27				1					
Nausea/vomiting	26	36	21			20	6		3	21	26	18
Sleeplessness	22		11			16					8	
Fever	10	11					1					
Significant variables												
Age	Yes			Yes	Yes							
Extraction	Yes			Yes	Yes					Yes		
Local anesthesia					Yes					Yes		
Length of case	Yes									Yes		
Other	Parental education			Parental presence							Sevoflurane	

* FLACC (Face, Legs, Activity, Cry, Consolability Pain Assessment Tool).

† DQ=dichotomous questionnaire—yes/no.

‡ VAS=visual analog scales—8- or 10-point.

§ SQ=scaled questionnaire—4-point.

|| RR=recovery room only

showed that there was a high correlation between pain scores measured by the nurses in the PACU and by the parents at home. Visual responses to pain were interpreted similarly by nurses and caretakers alike, demonstrating that nonprofessionals properly trained to use the FLACC pain scale can accurately assess pain in patients using this scale.

Postoperative pain. In this study, postoperative pain was experienced by 95% of the patients. The reported pain was generally moderate in intensity and greatest in the PACU. The reports of pain decreased steadily during the postoperative course, and none was reported beyond the fourth postoperative

day. Of all the postoperative outcomes evaluated, pain was sustained the longest, a finding reported by Atan et al.⁹ Pain was also a common finding in the majority of other studies investigating postoperative pain in children after receiving dental care under GA—the incidence of which ranged between 36% and 93% (Table 6).^{2-4,7,9-11} Three studies reported pain to be an uncommon occurrence (0-8%).^{5,6,8} It is important to note again when comparing these studies that there is great variability among the study designs, such as method and time(s) of pain assessment, age and medical status of the children, use of local anesthesia, and the quantity and types of procedures performed. For example, Vinckier et al reported

no pain in children with a mean age of 5 years receiving on the average 2 extractions and 7 restorations.⁶ All children, however, were given analgesics at the end of the procedure.

There are several possible explanations for why the children in our study had the highest rate of reported pain compared with those other studies. Our study was the only one to use the FLACC pain scale. This differs when compared with most other studies which used either dichotomous (yes or no) or narrower-scaled questionnaires^{1,2,4-8,11} or used standardized 8-, 9-, or 10-point visual analog scales.^{3,9,10} It is also important to note that no intraoperative local anesthesia was used nor were there any standard orders for the use of postoperative analgesics to be given in the recovery room. This was not the case in many of the studies cited in Table 6. Ersin et al reported that the use of sevoflurane resulted in more pain than their control group, the subjects of which were anesthetized with halothane.¹⁰ This may be due to the fact that halothane takes longer to dissipate than sevoflurane, which could account for a longer period of PACU time without pain. Since all of our patients were anesthetized using sevoflurane, this could explain our higher prevalence of PACU pain. Halothane was used more commonly than sevoflurane in the other studies,^{1,2,4,6,10} and in 2 of the studies the type of anesthetic used was not reported.^{3,11}

The present study examined numerous variables to determine if any were associated with the intensity of postoperative pain or other postoperative sequelae. There were no statistically significant associations between the gender or ethnicity of the children and reported pain. Atan et al also evaluated gender as a variable and failed to find an association with postoperative pain.⁹

Children of less-educated parents were more likely to report pain in both the preoperative and PACU periods. In a similar study, Fung et al reported that pain was greater when mothers were present, but did not measure parental education.³ Hosey et al found a significant relationship between postoperative morbidity and preoperative parent-reported child anxiety.¹¹ They suggest that the anxious child is more likely to suffer and/or their parent is more likely to report adverse sequelae. Other studies of postoperative pain after surgery in children, but not for dental procedures, support an association between education or SES and the reporting of pain.²²⁻²⁶ Perhaps the less-educated or low-SES parents are more anxious, which leads to more anxiety in their children and, thus, the reporting of more adverse outcomes such as pain. In a study of postextraction pain and analgesic usage in children having extractions in dental offices, Acs et al²⁷ concluded that parental expectations for postextraction pain may be based upon their own experiences or biases.

Children 4 years old or more were more likely to experience pain and required more analgesics during the recovery period. We believe that older children may be more verbal and demonstrative of their pain, while younger children have to rely on parental observation of pain which may have resulted

in underdiagnosis of pain and/or insufficient pain relief. Acs et al²⁷ also reported that increasing age was significantly associated with reports of pain after outpatient extractions in children. Nonetheless, these findings are in contrast to 2 studies cited in Table 6 that also evaluate pain as a function of age. Fung et al³ reported that children older than 9 years were less likely to report pain, and Noble et al⁴ reported that distress decreased linearly with age (mean age=7 years). Noble et al's 4-point distress scale (happy, no distress, distress but consolable, and distressed and inconsolable) was not a direct measurement of pain but is similar to the FLACC scores used in our study. It is difficult to explain why they found distress to decrease with age, while we found pain to be increased with age. It is important to note that our population was younger (median age=4 years), which may have been a factor. In addition, neither Fung et al nor Noble et al performed a multiple regression analysis that might have diminished or eliminated this contradictory association.

The type and number of dental procedures performed in our population were also a significant determinant of pain. Most subjects had a variety of dental procedures such as extractions, pulpotomies, SSCs, and amalgam or resin restorations. Children having extractions as the most invasive procedure were 7 times more likely to report pain after returning home and had the highest pain scores during the 1-week postoperative period. This finding agrees with several other studies cited in Table 6. Fung et al reported pain to be more likely if the child had more than 4 teeth extracted.³ Noble et al found that the greater the number of teeth extracted, the greater their distress reported—although with 4 or more extractions, the distress ratings began to plateau.⁴ Similarly, Atan et al reported that the odds of experiencing pain were elevated with increasing numbers of surgical procedures.⁹ Conversely, Chelliah et al reported that 88% of patients had mild or no pain after extractions and none required analgesics.⁷ The majority of their children studied, however, did receive intraoperative local anesthesia, which might explain their result.

Although patients with extractions had the highest pain scores during their course of recovery at home, no significant relationship was found between extractions and immediate postoperative pain in the PACU. One would expect patients with extractions to also have higher pain scores immediately postoperatively in the PACU, especially since no local anesthesia was administered intraoperatively. This may be explained by several factors. During extubation, 7 of the 90 patients were given fentanyl due to emergence agitation. This analgesic may have masked some of the pain in the PACU. In addition, the residual sedative effect of the GA may have minimized the postoperative PACU pain. Many clinicians use intraoperative local anesthesia to decrease immediate short-term postoperative pain from extractions. Our results, however, do not support the necessity of its use. The sedative effect of the general anesthetic and the selective use of postoperative analgesics in the recovery room when needed can effectively control pain. Most children in our study

spent at least 2 to 3 hours in the PACU, and any reduction of pain from the local anesthesia used intraoperatively would have dissipated by the time the patients reached home.

It is also possible that rater bias could result in parents' rating pain higher after extractions when compared to PACU nurses. Four of the 11 studies^{4,7,9,10} cited in Table 6 reported using local anesthesia intraoperatively, while others did not indicate in their methodology whether or not it was used. Noble et al⁴ and Atan et al⁹ both reported less distress and pain, respectively, when local anesthesia was used. Neither study, however, used a multiple regression analysis to explore possible covariates which may have increased, decreased, or eliminated the significance of this finding. It is important to note that in Noble's study, the procedures took a total of less than 10 minutes and the average age of the children was 7 years old compared to our study's average age of 4 years old. This may have been a factor, since age is a significant variable in the prevalence of postoperative pain. It has been our subjective observation in children that the numbness of the surrounding soft tissues can cause more distress to the child in the PACU than from the possible pain due to the extractions.

In addition to extractions causing more postoperative pain, children who were at least 4 years old and had more than 12 dental procedures were more likely to report pain. Therefore, in dental rehabilitations where these factors exist, it is important to instruct parents to give analgesics regularly for the first few postoperative days and not wait for pain to begin.

Other postoperative sequelae. Agitation was the second most common sequelae occurring in 76% of the children. As part of the GA protocol, all patients were induced using sevoflurane. Agitation after sevoflurane (ie, emergence delirium) lasts approximately 1 hour postoperatively, and its incidence varies. In a study by Ersin et al,¹⁰ the prevalence of postoperative agitation was found to be significantly higher in those children induced with sevoflurane when compared with those induced with halothane. This finding is supported by similar results from other studies in the pediatric population undergoing GA for nondental procedures.²⁸⁻³¹ The agitation decreased steadily and ceased by postoperative day 3.

In this study, 72% were given analgesics by the parents for pain during the recovery period at home. This is not surprising, since 95% of our patients reported pain, although 23% of children reporting pain were not given analgesics. In these cases, one can assume that the parents/caregivers did not feel that the intensity of pain warranted analgesics. Comparison with other studies is again difficult, since different protocols were used both intraoperatively and postoperatively regarding drugs used during the procedure, analgesic orders in the recovery room, and number and types of procedures performed. Hosey et al¹¹ reported that only 28% of their pediatric patients (mean age=7 years) having dental extractions needed analgesics, while Chelliah et al⁷ reported that no children (range=2-11 years old) who had an average of 6 extractions (no restorations) required analgesics.

Longer operative time was significantly related to increased postoperative sleepiness. Forty-three percent of the children were reported by their parents to feel sleepy after the procedure, which is similar to the prevalence rates reported by Holt et al² (45%) and Hosey et al¹¹ (48%). Atan et al reported that 84% of subject in their study were drowsy afterwards and that for every 10-minute increase in anesthetic time, the patient had a 15% increased odds of feeling sleepy postoperatively.⁹ In addition, they found that longer cases resulted in a higher prevalence of nausea. Enever et al reported that only 13% of their 55 patients (mean age=11 years) experienced drowsiness "more than usual," which may have been due to their older age population.⁵

Our study and that of Holt et al² study reported identical prevalence rates of 27% for children having sore throat postoperatively. Most subjects in our study were intubated atraumatically. Not surprisingly, the 9 subjects who had traumatic intubations were more likely to have sore throats and have greater pain in the PACU but not at home. Lower prevalence rates of sore throats were reported by Enger et al¹ (4%) and Vinckier et al⁶ (1%).

Nausea or vomiting after dental rehabilitation occurred in 26% of the subjects, which is similar to the prevalence rates reported in 6 similar studies,^{1,2,5,9-11} but higher than reported by Vinckier et al⁶ (6%) and Prabhu et al⁸ (3%)(Table 6). In our study, fentanyl was administered to patients who exhibited emergence agitation prior to entering the PACU for recovery. This may have accounted for some of the nausea, since several studies have reported that administering opioids can increase the occurrence of postoperative nausea and vomiting.³²⁻³⁴ Nausea and vomiting could also be due to a number of other issues, including the site and nature of the procedure (eg, the swallowing of blood), the drugs used pre, intra-, and postoperatively (eg, opioids), and oral intake of food or fluids pre- and/or postoperatively.

In our study, difficulty sleeping following dental rehabilitation was reported in only 22% of subjects. Other studies have also reported sleeplessness to be an uncommon sequelae following operative procedures. Holt et al² reported difficulty sleeping in 11% of their patients undergoing dental procedures, while Caldwell-Andrews et al³⁵ reported sleeplessness in 22% of pediatric patients undergoing outpatient elective nondental surgery.

Fever was the least reported of the symptoms in our study (10%). Vinckier et al was the only other similar study that reported postoperative fever, and they found an even lower prevalence rate of 1%.⁶ A number of factors can cause post-operative fever in children, including bacteremia, tissue trauma, drugs such as atropine, pulmonary atelectasis, dehydration, and environmental factors such as room temperature and the draping of the patient during the procedure.³⁶

A minor limitation of this study was our inability to sufficiently study the effects of treatment on permanent teeth due to elimination of the analysis of the small number of patients with dental treatment on permanent teeth. More pain and distress might have been expected with treatment of permanent

teeth, due to the fact that they are larger and that restorative treatment and extractions would have resulted in more dentinal, pulpal, and/or soft tissue trauma. Nonetheless, the current study's results indicate that most postoperative sequelae occurred within the first 24 hours following the procedure. These sequelae decreased significantly thereafter and lasted no longer than 4 days following the procedure, with pain being sustained the longest. Age was a significant variable influencing the prevalence of patient morbidity. Older children (at least 4 years old) not only reported more pain, but were also more nauseous, had more postoperative sleepiness, and required more analgesics during the recovery period. This may be explained by the fact that older children are more verbal and communicative of their symptoms.

When the findings of our study and those of the other similar studies cited in Table 6 are reviewed, 4 variables relevant to postoperative sequelae affecting children who undergo dental restorations and/or extractions under GA are evident:

1. Age—our study and 2 others indicate that age plays a role, but with contradictory findings.^{3,4}
2. Extractions—3 studies in addition to ours indicate that having extractions resulted in more pain.^{3,4,9}
3. Local anesthesia—2 studies clearly indicated that the use of local anesthesia decreased pain, but our findings did not support its use.^{4,9}
4. Length of case—our study and that by Atan et al both reported that the longer the child is under GA, the longer the child feels drowsy or sleepy postoperatively.⁹

This study's findings can help dentists who perform dental rehabilitations on children under GA advise their parents/caregivers what children experience postoperatively.

Conclusions

Based on this study's results, the following conclusions can be made regarding postoperative sequelae for children undergoing dental rehabilitations:

1. Children commonly experience postoperative symptoms such as pain, agitation, and sleepiness after dental rehabilitations, and they significantly decrease by the second and cease the fourth or fifth postoperative day.
2. PACU nurses can predict a child's postoperative pain experience at home.
3. Children who were at least 4 years old are more likely to report pain initially at home, required more pain medication, and have more postoperative sleepiness and nausea.
4. Children who have extractions are more likely to experience pain at home.
5. Children who are at least 4 years old and have 12 or more dental procedures were more likely to experience pain initially at home.
6. Parents with less education are more likely to report postoperative pain for their children.

7. Children who have longer operative times are more likely to experience postoperative sleepiness.
8. Children who have a traumatic nasotracheal intubation are more likely to have greater pain in the PACU and experience sore throats at home.

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