Postoperative Pain in Children After Dentistry Under General Anesthesia

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The objective of this study was to determine the prevalence, severity, and duration of postoperative pain in children undergoing general anesthesia for dentistry. This prospective cross-sectional study included 33 American Society of Anesthesiology (ASA) Class I and II children 4–6 years old requiring multiple dental procedures, including at least 1 extraction, and/or pulpectomy, and/or pulpotomy of the primary dentition. Exclusion criteria were children who were developmentally delayed, cognitively impaired, born prematurely, taking psychotropic medications, or recorded baseline pain or analgesic use. The primary outcome of pain was measured by parents using the validated Faces Pain Scale-Revised (FPS-R) and Parents' Postoperative Pain Measure (PPPM) during the first 72 hours at home. The results showed that moderate-to-severe postoperative pain, defined as FPS-R ≥ 6 , was reported in 48.5% of children. The prevalence of moderate-to-severe pain was 29.0% by FPS-R and 40.0% by PPPM at 2 hours after discharge. Pain subsided over 3 days. Postoperative pain scores increased significantly from baseline ($P < .001$, Wilcoxon matched pairs signed rank test). Moderately good correlation between the 2 pain measures existed 2 and 12 hours from discharge (Spearman rho, correlation coefficients of 0.604 and 0.603, $P < .005$). In conclusion, children do experience moderate-to-severe pain postoperatively. Although parents successfully used pain scales, they infrequently administered analgesics.

Key Words: Postoperative pain; Assessment; Anesthetic; Children.

Pain is defined as an unpleasant “subjective experience that is the product of both emotional and sensory components interrelated with the context of culture and environment.”¹ It is a concrete experience and an abstract concept.² Pain results from actual or potential tissue damage, but the perception of pain is modified by physiological mechanisms in the complex human nervous system.

Current clinical practices show that health care providers and parents tend to underestimate children's

pain when compared with children's self-reports.³ This incongruity results from the inability of young children to fully understand, verbalize, and express their experiences^{4–6} in conjunction with adults being unable to adequately detect and identify signs of pain in the pediatric population. Given that pain in children is inherently difficult to assess, pain may be unrecognized or undiagnosed resulting in a mistaken belief that infants and children suffer less than adults or do not feel pain.⁷ The International Association for the Study of Pain acknowledges that the “inability to communicate verbally does not negate the possibility that an individual is experiencing pain and (is) in need of appropriate pain management.”⁸

Dental extractions of primary teeth have been, and very often still are, carried out without any pain relief

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Figure 1. Patient flow diagram.

medication in the belief that children do not experience significant amounts of pain.⁹ Studies conducted to describe dentists' knowledge of and attitudes towards procedural pain in children have revealed that dentists downplay procedural pain.^{10–12} Pain is likely the most significant morbidity associated with dental extractions.^{13–15} However, for unknown reasons, the impact of these studies has been slow to permeate into clinical knowledge and translate into clinical intervention.

Postoperative pain is often a new experience for young children. The complexity of interpreting and verbalizing pain may be convoluted further by unfamiliar postoperative sensations from general anesthesia (GA), surgical site discomfort, and disorientation. The recovery period after surgery may require formal assessments of pain in this population.

Our literature review identified 6 publications that studied morbidity following pediatric dental rehabilitation under GA^{1,9,13,15–23} and 4 studies that focused on postoperative pain as their primary outcome.^{15,19,22,23} While collective interpretation of these previous studies was difficult with the variability in age, demographics, and implemented pain assessment tools, postoperative pain remained the most common and long-lasting morbidity after pediatric dental rehabilitation.^{13,14,16} In the study by Atan et al,¹³ postoperative pain was reported in 74% of children aged 6 to 16 years following dental treatment under intubated GA. Of the morbidity measures reported, pain had the longest duration in comparison to sleepiness, weakness, and nausea. Farsi et al¹⁸ determined that the prevalence of postoperative pain was 47.8% at 36 hours and 16.7% at 72 hours. The pilot study by Fung et al¹⁵ found that

57.5% of 40 children who had 1 or more extractions under GA had postoperative pain immediately after treatment. In the study by O'Donnell et al,⁹ none of the 70 patients in the no-analgesia group reported “no pain” and 100% scored mild to high pain; 18.6% scored moderate pain and 81.4% scored moderate-to-high pain. All children receiving no analgesia experienced some level of pain following extractions of primary teeth under GA.

The variability in the current literature, the variability in clinicians' perceptions of children's postoperative pain, and the variability in home recovery practices prompted this study. The objectives of this study were to determine the prevalence, severity, and duration of postoperative pain after pediatric dental rehabilitation under GA using reliable and valid pain assessment tools in the clinic and at home.

MATERIALS AND METHODS

This prospective cross-sectional study was approved by the University of Toronto Research Ethics Board and conducted at the university's dental surgicenter.

A summary of the flow of subjects is shown in Figure 1. Subjects were recruited from referrals to the surgicenter, which included patients who previously failed to undergo treatment successfully with oral moderate sedation, nitrous oxide sedation, or local anesthesia alone for reasons of poor cooperation or extensive dental treatment plan requiring multiple appointments. Recruitment of participants occurred in 3 stages. Participants were screened at the initial

Table 1. Inclusion and Exclusion Criteria

<i>Inclusion criteria</i>
Participants were:
<ul style="list-style-type: none"> • Referred for dental treatment under general anesthesia in the surgicenter • Ages 4 to 6 inclusively at the time of surgery • American Society of Anesthesiology (ASA) physical status Class I or II • Living with an English-speaking parent/caregiver • Requiring oral rehabilitation involving multiple dental procedures (including at least 1 extraction, and/or pulpectomy, and/or pulpotomy) of the primary dentition • Absence of baseline pain as measured by Faces Pain Scale-Revised ≥ 6 preoperatively
<i>Exclusion criteria</i>
Participants could not be:
<ul style="list-style-type: none"> • Developmentally delayed or cognitively impaired • Born prematurely (defined as 37 weeks' gestational age) • Currently using psychotropic medications • Using analgesics preoperatively on the day of the procedure

preoperative consultation by the pediatric dental resident to determine eligibility based on age, English fluency, and treatment requirements. If criteria were met, the patient's chart was flagged as belonging to a potential participant. At the patient's preoperative anesthesia consultation, the anesthesia resident performed the assessment as per usual procedures and verified that the potential participant met all inclusion and exclusion criteria. The study was explained and the information sheet and consent form were given to the parent/caregiver to review at home. On the day of the procedure (typically scheduled 2 to 4 months after the consultation appointment based on current surgicenter wait times), the parent/caregiver reviewed and signed the information letter and consent form. Inclusion and exclusion criteria are shown in Table 1.

Sample Size Calculation and Power

This study aimed to achieve a 90% power with an alpha level set at .05. Prevalence of postoperative pain is reported to be 57.5% by Fung et al.¹⁵ Discussions with 5 pediatric dentists revealed the expectation that postoperative pain was minimal. Given this expectation, a median value between zero and 0.575 of $P = .30$ was selected for the calculation. To anticipate 20% of the parents not returning survey forms, the calculated sample size of 32 was increased to 40 patients.

Selection of Pain Assessment Measures

Assessment tools were selected to measure pain in ages 4 to 6 years in the acute postoperative setting. This study used a validated faces pain scale self-report tool and observational-behavioral pain assessment tool at home after discharge from dental rehabilitation under GA. Only postoperative pain assessment tools that demonstrated discriminant validity (ie, pain vs no pain), construct validity, test-retest reliability, internal consistency, interpretability, and feasibility were considered.^{24–27}

Self-Report Tools. Children's self-report of their pain is the gold standard and preferred over observational reports, given that pain is a subjective experience.^{3,17}

Faces Pain Scale-Revised. The selection of the Faces Pain Scale-Revised (FPS-R) for this study was based upon its appropriateness and preference in children,³ advantages, reputability, and interpretability.^{24,25,27} The FPS-R design consists of a row of 6 gender-neutral faces outlined in black overtop a white background (Figure 2, bottom). FPS-R is appropriate for children as young as 4 years of age. The tool is simple and does not require the child patient to make metaphoric leaps to interpret the scale (a skill that is undeveloped until age 7).²⁸ Children can interpret pictorial faces reacting to pain and can interpret severity.²⁸ They can relate their own pain intensity to diagrammatic faces better than to specific persons in photographs.²⁸ Additionally, the absence of cultural features increases the tool's versatility in different populations. FPS-R can be considered a universal tool.²⁹ Schiavenato et al³⁰ theorized the "primal face of pain" is intrinsic to human beings where the facial expressions of pain are constant across racial and ethnic groups. FPS-R has been developed to omit smiles and tears. The use of a neutral face rather than a classic happy face to denote the no-pain anchor increases the sensitivity of the tool in measuring pain.³¹ Studies found that faces pain scales with smiling no-pain anchors may provide greater pain scores in comparison with other scales.³² Furthermore, a faces pain scale is preferred by children as opposed to a color analog scale or a visual analog scale.^{3,28,32}

Advantages of using the FPS-R include its simplicity, minimal training requirement, and low burden of materials. Furthermore, no pretesting for the child's cognitive maturity is required. The presence of a numeric scale that has content validity, construct validity, and feasibility, facilitates statistical analyses.³³

The FPS-R is a reputable pain assessment tool, recommended for clinical research by Stinson et al.²⁵ The data generated from FPS-R are qualitative-categorical and ordinal. The scale correlates with other self-

Faces Pain Scale-Revised Instructions:

"These faces show how much something can hurt. This face (point to left-most face) shows no pain. The faces show more and more pain (point to each from left to right) up to this one (point to right-most face) – it shows very much pain. Point to the face that shows how much you hurt (right now)".

Figure 2. Comparison between Faces Pain Scale (top) and Faces Pain Scale-Revised (bottom).

report pain measures: $r = 0.84$ with the color analog scale and $r = 0.92$ with the visual analog scale.³³

Interpretation of the FPS-R requires the delineation of moderate-to-severe pain, which is when most clinicians believe treatment is required. Gauthier et al³⁴ determined that pharmacologic intervention was required when subjects indicated a mean pain intensity of 3.2 by Faces Pain Scale (FPS, the original 7-faces scale with scoring range from 0 to 6; Figure 2, top). Based on the findings by Gauthier et al,³⁴ a score of 3.2 would correspond to the fourth face of the FPS. The features in this facial expression appeared to transition between face number 3 and face number 4 of the revised version, which consists of a 6-faces scale. The decision was made by the principal investigator to make the selection of face number 4 (score 6) and up to be the indicator for clinically significant pain (moderate-to-severe pain).

Observational Behavioral Measures. Observational measures are popular among health care providers because these assessment tools do not require active cooperation from the child patient. The pain assessment tools are easy to use. The listing of behaviors is scored to determine pain intensity. The Parents' Postoperative Pain Measure is the only tool specifically designed for parents to use at home.

Parents' Postoperative Pain Measure. The Parents' Postoperative Pain Measure (PPPM, Figure 3) is a

Parents' Postoperative Pain Measure Instructions:

Answer yes or no to the following fifteen questions.

Add the number of 'yes' to acquire a total score.

Does your child:

- ☐ Whine and complain more than usual?
- ☐ Cry more easily than usual?
- ☐ Play less than usual?
- ☐ Not do the things s/he normally does?
- ☐ Act more worried than usual?
- ☐ Act more quiet than usual?
- ☐ Have less energy than usual?
- ☐ Refuse to eat?
- ☐ Eat less than usual?
- ☐ Hold the sore part of his/her body?
- ☐ Try not to bump the sore part?
- ☐ Groan or moan more than usual?
- ☐ Look more flushed than usual?
- ☐ Want to be close to you more?
- ☐ Take medications when normally refuses?

Figure 3. Parents' postoperative pain measure.

Table 2. Restrictions on General Anesthesia Technique in This Study

- Oral premedication with midazolam was used if the child required sedation prior to entering the surgical suite. Midazolam was administered with simple syrup or flavored syrup which had no active pharmacologic components. These vehicles were used to mask the bitter taste of midazolam.
- Acetaminophen and ketamine as a premedication were prohibited.
- Fentanyl was limited to the induction period (at least 1 hour prior to emergence).
- Remifentanyl use was acceptable given that it had a short duration of action of less than 10 minutes.
- Ketorolac use was prohibited preoperatively and intraoperatively.

15-item behavioral checklist based on nonverbal pain cues that parents or caregivers may observe postoperatively at home. Points greater than or equal to 6 signify the presence of moderate-to-severe pain.² This observational behavioral scale is age appropriate for ages 4–12 years. It has been validated in the outpatient ambulatory setting and is designed for parents to use easily at home. The checklist format makes the tool of low burden. It is a well-established measure with high interrater reliability, internal consistency, good indices of construct validity, sensitivity, specificity, and responsiveness.³ Von Baeyer and Spagrud²⁶ recommended it as a first choice for pain assessment at home.

Procedure and Treatment

The staff dental anesthesiologist and resident administered anesthesia while the pediatric dental resident, under supervision of the staff pediatric dentist, performed the dental procedures. The principal investigator was not involved in direct patient care.

Anesthetic protocols were standardized to a limited extent to simulate nonacademic practice. Intravenous analgesics are not always given routinely in many practices, including both hospital and ambulatory settings. The current standard of practice is variable in this regard. Analgesic agents are administered by anesthesiologists based on their own clinical judgments and often in consultation with the surgeon. For this study, limitations on perioperative analgesics were implemented to control for their confounding effect on postoperative assessments. Patients received treatments that met current standards of care. The restrictions on the GA technique that were implemented are shown in Table 2.

In recovery, analgesics for obvious pain could be administered only after pain measurements were ac-

quired or attempted twice without success. Clinicians identified obvious pain to be prolonged distress and inconsolability. Children's ibuprofen was the first-line agent administered by mouth. If the patient refused oral intake, intravenous ketorolac was administered as a rescue.

Data Collection

Data on pain were collected in 2 stages. The presence or absence of preoperative pain and analgesic use was acquired in the screening and final recruitment appointments. Then, postoperative pain was measured by the designated parent/caregiver immediately in the recovery area and subsequently at home upon discharge from the clinic.

Training the Parent on Pain Assessment Tool and Measure. Introduction of the pain scales occurred on the day of surgery, prior to giving any premedication to the patient. The child was shown the FPS-R assessment tool in the presence of the parent/caregiver in the preoperative room and asked to select a face. This pain score was noted, and the child continued with regular preoperative procedures. Once the child was admitted into the surgical suite and undergoing treatment, the nurse returned to the preoperative area and trained the designated parent or caregiver to use the 2 pain assessment tools for home-use. As the final step of training, the parent administered the FPS-R postoperatively in the recovery area with their child. Opportunities for the parent/caregiver to ask questions pertaining to the tools were given throughout the training.

Take-Home Data Collection and Survey. The take-home pain assessment package that the parent/caregiver received included:

- tools marked by assessment date/time,
- a stamped envelope for the return of items,
- a postoperative instruction sheet,
- a prescription for analgesics, and
- a sample of children's ibuprofen.

The prescription included either ibuprofen 10 mg/kg every 6 hours as needed for pain or, if contraindicated, acetaminophen 10–15 mg/kg every 6 hours as needed for pain. The parent was asked to record analgesic name, administration time, and dose on the diary sheet provided. Parents were advised that the pain medication could be administered at times other than the assessment time, if desired (Figure 4). The designated parent or caregiver was also asked to administer and record the FPS-R and the PPPM when they arrived at home, and 2, 12, 24, 48, and 72 hours after discharge. The

Figure 4. Assessment timeline.

designated parent or caregiver was advised not to wake the child for assessments. Assessment tools could be administered after the child was awake. Notation of this event would be made in the diary.

Parents were asked to rate their satisfaction regarding their use of the FPS-R and PPPM by using a Likert scale with 1 = not at all satisfied and 5 = extremely satisfied before returning all survey materials by mail.

Statistical Analyses

All data were processed in the Statistical Package for the Social Sciences (SPSS, version 20, SPSS Inc, Chicago, Ill), and a significance level of .05 was used in all tests. The following analyses were performed.

Demographic and baseline characteristics, proportions or percentages, means, and standard deviations of data were collected. Prevalence of moderate-to-severe pain was indicated by FPS-R score and PPPM ≥ 6 at 2, 12, 24, 48, and 72 hours. Overall prevalence of moderate-to-severe pain, reported as FPS-R ≥ 6 at any time during the recovery period, was determined. Wilcoxon matched pairs signed rank test was used to determine if postoperative pain reported by FPS-R differed from baseline scores. Spearman rank correlation

coefficients were determined between FPS-R and PPPM at corresponding time points. Frequency of analgesic doses received by patients during the recovery period was tracked.

Correlation analyses between delta FPS-R and treatment types were performed as post hoc analyses. Delta FPS-R was devised for this study and was defined as the greatest FPS-R value within the initial 12-hour postoperative period minus the preoperative FPS-R value. Correlation coefficients, Kendall tau and Spearman rho, were determined where positive correlations existed.

The management of lost to follow-up and missing values from the pain assessment surveys required care. The values in this study were considered as missing at random.^{35,36} Low socioeconomic status may be a mechanism for parents not performing assessments at times. Case deletion approach or exclusion of missing data seemed appropriate because prevalence was the outcome of interest. The frequency of missing values was reported transparently in Figures 5 and 6. The decision was made not to substitute measures of central tendency, which would skew data analyses and bias

Figure 5. Faces Pain Scale-Revised versus time.

Figure 6. Parents' postoperative pain measure versus time.

Table 3. Demographic and Anesthetic Data

Variable	Sample (n = 33)		Lost to Follow-up (n = 5)	
	N	%	N	%
Gender				
Male	17	51.5	1	20.0
Female	16	48.5	4	80.0
Age, y				
4	9	27.3	2	40.0
5	14	42.4	2	40.0
6	10	30.3	1	20.0
Physical status*				
ASA 1	28	84.8	4	80.0
ASA 2	5	15.2	1	20.0
Premedication				
None	21	63.6	2	40.0
Midazolam	12	36.4	3	60.0
Inhalational induction				
Sevoflurane with nitrous	31	93.9	5	100.0
Sevoflurane alone	2	6.1	0	0
Intravenous infusion				
None	2	6.1	0	0
Propofol	0	0	0	0
Propofol + remifentanyl	28	84.8	4	80.0
Remifentanyl alone	3	9.1	1	20.0
Vapors for maintenance				
None	8	24.2	1	20.0
Sevoflurane	4	12.1	0	0
Isoflurane	20	60.6	4	80.0
Sevoflurane/isoflurane	1	3.0	0	0
Local anesthesia used				
None	10	30.3	1	20.0
2% lidocaine 1 : 100,000 epinephrine	23†	69.7	4	80.0
Opioid adjunct				
None	11	33.3	1	20.0
Fentanyl bolus‡	22	66.7	3	60.0
Fentanyl infusion	0	0	1	20.0
Adjunct medications				
Midazolam	1	3.0	0	0
Atropine	7	21.2	2	40
Glycopyrrolate	10	30.3	1	20
Atropine + glycopyrrolate	1	3.0	0	0
Dexamethasone	23	69.7	2	40
Analgesic use in recovery				
None	23	69.7	5	100.0
Ibuprofen, orally	8	24.2	0	0
Ketorolac, intravenously	2	6.1	0	0
Procedure time, min	Mean 124.0, SD 40.7		Mean 120.0, SD 27.5	
0–60	1	3.0	0	0
61–120	12	36.4	2	40.0
121–180	18	54.5	3	60.0
181–240	2	6.1	0	0
Anesthesia time, min	Mean 143.7, SD 43.9		Mean 140.4, SD 27.6	
61–120	11	33.3	1	20.0
121–180	17	51.5	4	80.0
181–240	5	15.2	0	0

Table 3. (Continued)

Variable	Sample (n = 33)		Lost to Follow-up (n = 5)	
	N	%	N	%
Recovery time, min	Mean 55.7, SD 19.2		Mean 60.0, SD 24.1	
21–40	8	24.2	1	20.0
41–60	15	45.5	3	60.0
61–80	7	21.2	0	0
81–100	1	3.0	0	0
>100	2	6.1	1	20.0

* ASA indicates American Society of Anesthesiology.

† One case also received 0.5% bupivacaine 1 : 200,000 epinephrine.

‡ More than 1 hour before the end of the procedure.

interpretation of prevalence for nonparametric data.^{35,36}

RESULTS

As seen in Figure 1, a total of 323 patients attended the initial consultation appointments with pediatric dental residents. Of these, 55 were accepted based on age, English comprehension, and treatment requirements. Six were subsequently deemed unacceptable study candidates because of poor English facility and medical reasons such as malignant hyperthermia susceptibility, developmental delay, or the presence of pain. Seven patients were unavailable because (a) they sought private practice, (b) opted for moderate sedation via oral/nitrous-oxide instead of general anesthesia, or (c) were unavailable during the 12-month study period. Four parents declined enrollment in the study without specific reasons. Subsequently, a convenience sample of 38 patients was recruited and enrolled in this study. One participant was disqualified when a fentanyl infusion was mistakenly administered at the end of the anesthetic. Postoperative assessment tools were not given to this patient. Four parents failed to return assessment and questionnaire materials despite being reminded by telephone. Reasons that were given by 2 parents included “inconvenience”; otherwise, no reasons were given. Thirty-three patients returned materials, thereby surpassing the calculated sample size of 32 at 90% power. The response rate of 89.2% (33/37) was achieved.

Demographic data are shown in Table 3.

Anesthesia regimens are summarized in Table 3 and were similar among the cases.

Ibuprofen was administered in 8 cases after acquiring or attempting to acquire a self-report pain score. Intravenous ketorolac was used in 2 cases when the child refused oral medication but was in obvious

discomfort. No anesthetic complications were observed.

Pain Assessment Results

Prevalence. The number of children who reported moderate-to-severe pain, defined as FPS-R ≥ 6 , during the 72-hour recovery period was 16/33 (48.5%).

For each time of assessment, the prevalence of pain was calculated with denominators excluding missing values (Table 4). The prevalence of moderate-to-severe pain was 29.0% by FPS-R ≥ 6 scores (highest at 2 hours after discharge from the clinic) and correspondingly, 40.0% by PPPM ≥ 6 at the 2-hour mark.

Proportions of No, Mild, Moderate, and Severe Pain. The stacked bar graph (Figure 5) illustrates that almost all study participants had no pain at baseline. Baseline pain assessment scores that were elevated may demonstrate chronic discomfort. Postoperative pain scores by FPS-R demonstrate the presence of moderate-to-severe pain greatest within the initial 2 hours and gradually tapering towards mild and no pain over the 3-day postoperative period. A similar pattern is observed by the PPPM (Figure 6).

Wilcoxon matched pairs signed rank test confirmed that postoperative pain was significantly greater than baseline by FPS-R ($P < .001$). For the postoperative score, the highest score given within the first 12 hours was used for the comparison.

Spearman correlation coefficient analysis revealed statistically significant positive correlations between FPS-R and PPPM at equivalent time points (Table 5).

Despite a child's self-report of moderate-to-severe pain (FPS-R), parents rarely gave their child analgesics over the 3-day postoperative period (Table 6). All parents received written and verbal instructions on analgesic use along with a sample of children's ibuprofen. They were encouraged to give round-the-

Table 4. Prevalence of Moderate-to-Severe Pain*

	<i>Recovery</i>	<i>Home</i>	<i>2 Hours</i>	<i>12 Hours</i>	<i>24 Hours</i>	<i>48 Hours</i>	<i>72 Hours</i>
FPS-R ≥ 6 , n	5/25	8/27	9/31	5/28	2/31	2/32	1/32
FPS-R ≥ 6 , %	20.0	9.6	29.0	17.9	6.5	6.3	3.1
PPPM ≥ 6 , n	N/A	11/26	12/30	5/24	1/29	0/29	0/29
PPPM ≥ 6 , %		42.3	40.0	20.8	3.4	0	0

* FPS-R indicates Faces Pain Scale-Revised; PPPM, Parents' Postoperative Pain Measure; n, number of patients who reported pain by the pain measure out of the total number of patients who responded.

clock dosing for at least 2 days. Only 1 parent routinely gave analgesics round-the-clock as instructed. The majority of the doses shown in Table 6 are from this parent's administration behavior.

Post hoc analyses revealed a fair correlation between delta FPS-R and sum of pulp therapies and extractions. As for correlation coefficients, Kendall tau was 0.275 ($P = .041$) and Spearman rho was 0.380 ($P = .029$). There appeared to be no correlation between delta FPS-R score and any other dental procedure or use of local anesthesia.

DISCUSSION

This study found that 48.5% of children self-reported moderate-to-severe pain during the 72-hour postoperative period. Furthermore, the prevalence of pain was reported to be 29% by FPS-R and 40% by PPPM and highest at 2 hours from discharge.

This study identifies the high prevalence of postoperative pain in pediatric dentistry after GA and brings to the forefront the need for formalized assessment in the recovery period. In 1998, the World Health Organization named pain as the fifth vital sign, highlighting the importance of its assessment.³³ The early hours exhibit the most pain. Moderate-to-severe pain appears to peak at 2 hours, then reduces in intensity over the 3-day period, a trend which is consistent in morbidity studies focusing on pediatric dental surgery under GA.^{18,19,22}

The prevalence of 42.3% by PPPM scores was highest at home arrival. However, interpretability of this score at this period is difficult because some of the PPPM items required a longer duration of observation.

There was moderately good correlation of the pain measures when the patient arrived home and at 2, 12, 48, and 72 hours, as well as fair correlation at 24 hours. The strength of the correlation at early time points may reflect the obvious nature of behavioral verbal and nonverbal cues. Parents may also be more vigilant when monitoring during the initial recovery period. The correlation coefficients between PPPM and FPS-R (Table 5) were comparable to the values reported by Chambers

et al³⁷ who compared PPPM to FPS (original 7-faces version). The study determined Spearman rho correlation coefficient of PPPM and FPS in older children ages 7–12 to be 0.64 and 0.53 on days 1 and 2, respectively ($P < .001$). In the ages 2–6 years, the Spearman rho correlations were 0.72 and 0.62 on days 1 and 2, respectively ($P < .001$).

The strength of the correlation found in this current study and reported in other studies raises the question whether PPPM can be used alone. While the utility of combining the self-report measure (FPS-R) and the observational behavior measure (PPPM) provides greater information and may offer a learning tool for children and parents in their interpretation of pain, a single measure may be more practical for parents and caregivers.

Implementability of Pain Assessment Tools in the Ambulatory Clinic

Cooperation is difficult to elicit from an agitated and disoriented child in the immediate postoperative period. In this current study, the use of the FPS-R by parents on their child during the recovery period before discharge was a demonstration of successfully completing training. The reliability of the FPS-R during this potentially tumultuous time is unknown. For this reason, recovery nurses prefer an observational behavior tool like the FLACC scale (face, legs, activity, cry, and consolability scale). At times, recovery nurses found FPS-R to be burdensome if a face selection could not be obtained. This is described as “provider burden” by Hester et al.³⁸

While it is ideal to use both self-report and observational behavioral pain assessment measures as suggested in the pain literature, the sole use of an observational behavior pain tool alone may be more practical and appropriate in ages 4 to 6 in the immediate postoperative period.

At the time of discharge, our nurses felt that providing the PPPM checklist empowered parents to objectively assess pain at home. The time to train parents was minimal and did not impede the nurses' routines.

Table 5. Spearman Rank Correlation Coefficient Between Faces Pain Scale-Revised and Parents' Postoperative Pain Measure at Concordant Times

	Home	2 Hours	12 Hours	24 Hours	48 Hours	72 Hours
Correlation coefficient, ρ_s	0.616	0.604	0.603	0.364	0.382	0.392
<i>P</i> value (2-tailed)	.001*	<.001*	.002*	.057	.041†	.035†
N	26	30	24	28	29	29

* Correlation is significant at the .005 level (2-tailed).

† Correlation is significant at the .05 level (2-tailed).

Parental Satisfaction With Use of Pain Assessment Tool

Ninety-six percent of parents were satisfied with either pain assessment tool. Fifty percent of parents were extremely satisfied with the FPS-R, while 44% of parents were extremely satisfied with the PPPM (Figure 7). Few comments or suggestions were submitted. One mother appreciated that the FPS-R allowed her direct means for her daughter to communicate discomfort in a manner that was quantifiable.

In dentistry, little is known about parental practices of analgesic administration. This current research identified that parents rarely provided analgesics to their child despite their child's self-reports of moderate-to-severe pain. This finding is consistent with other studies in the medical literature^{4,39–41} that show administration of analgesics to children is lacking at home. In the study by Fortier et al³⁹ who observed children after tonsillectomy and adenoidectomy, researchers found only 24% received no or just 1 medication dose throughout the entire first day at home despite the parental rating that 86% of children experienced significant overall pain. On day 3 after surgery, although 67% of children were rated by parents as experiencing significant overall pain, 41% received no or 1 medication dose throughout the entire day.

The provision of ibuprofen samples to parents in this current study was to ensure access to analgesics. Despite available analgesics, few doses were administered to children postoperatively. Interestingly, the recently published randomized-controlled study by Hegarty et al⁴² found the prevalence of moderate-to-severe postoperative pain to be 41% in the group that was prescribed analgesics compared to 38% in the group that was prescribed and supplied analgesics at discharge. There appeared to be no difference in the incidence of pain between the 2 groups. While parents were able to use

the Wong-Baker Faces Scale and PPPM at home, Hegarty et al⁴² determined only 48% of parents recalled advice pertaining to analgesia.

Secondary analyses revealed a fair correlation by Kendall tau, which was 0.275 ($P = .041$), and moderate correlation by Spearman rho, which was 0.380 ($P = .029$), when comparing treatment (the sum of pulp therapies and extractions) and delta FPS-R pain score. Further study is required before an association or cause-effect relationship can be established. In contrast, Fung et al¹⁵ found no indication that number of teeth treated was important. The study by Fung et al¹⁵ may have alluded to the possible greater role that a multi-rooted molar, rather than a single-rooted incisor, may have on pain. Based on neurobiology, the presence of pain after dental extractions and pulp therapy is anticipated. The review by Sessle⁴³ discusses trigeminal nerve deafferentation, which occurs in endodontic therapy and tooth extraction. Neural trauma, compression, or transection occurs in these procedures. The sensory changes may lead to painful conditions. Additionally, neuroplasticity may play a role in pain whereby there is increased neuronal excitability and thus central sensitization.⁴³ This pain pathway is initiated by injury and inflammation stimulating nociceptive afferent neurons.

Other predictors of pain, such as headache, sore nose, and sore throat from intubation and throat pack placement were not determined. This current study did not discern the type of pain that was present. The primary outcome of this study identified presence and intensity of pain, not characterization or localization of pain.

Local anesthesia should have had minimal impact on postoperative pain reports.^{1,44–46} Seventy percent of the cases received 2% lidocaine with 1 : 100,000 epinephrine given by infiltration with an anticipated duration of action in soft tissue of approximately 3 hours. The analysis performed used the highest FPS-R score

Table 6. Total Frequencies of Analgesic Doses

Time After Discharge	2 Hours	12 Hours	24 Hours	48 Hours	72 Hours
Number of analgesic doses	6	10	5	2	1
Number of patients represented	6	6	3	1	1

Figure 7. Parental satisfaction.

within the first 12 hours after discharge overcoming the local anesthetic effect.

The likelihood of elevated FPS-R scores secondary to hyperalgesia in the immediate postoperative period is low. Of the sample of 33 patients, 23 patients received propofol-remifentanyl combination, and 3 patients received plain remifentanyl infusion in this current study. Overestimations of postoperative pain because of remifentanyl-induced hyperalgesia (defined as an increased sensitivity to noxious stimuli) are not supported by the literature. Angst et al⁴⁷ performed a rigorous study using healthy adult volunteers subjected to mechanical, electrical, and thermal stimuli to refute the development of acute tolerance to clinically relevant concentrations of remifentanyl for infusions of 3-hour duration. These authors referenced observational studies to suggest that tolerance develops in the context of chronic opioid therapy. Furthermore, hyperalgesia does not necessarily translate to increased analgesic requirements of nonopioids. In addition to a lack of direct evidence linking intraoperative opioid use to postoperative hyperalgesia in a clinical setting,⁴⁸ there are no studies on opioid-induced hyperalgesia in pediatrics.

The results of this study suggest that preemptive analgesics should be considered intraoperatively to facilitate bridging to oral analgesics like children's ibuprofen or acetaminophen to be given at home.

Furthermore, the results suggest that postoperative instructions should emphasize round-the-clock dosing for at least 2 days instead of recommending "as-needed for pain" dosing.

In conclusion, this study is the first to have parents assess their child patient by using the FPS-R and PPPM to capture the pediatric postoperative experience after dental GA. Postoperative pain exists in the early recovery period with greatest severity at 2 hours after the patient is discharged home. Moderate-to-severe

postoperative pain, defined as FPS-R ≥ 6 , was reported in 48.5% of children during the 72-hour recovery period. While moderate-to-severe pain existed, for unknown reasons, parents demonstrate an aversion to analgesic use.

If there is an unmet need for analgesics, as previous studies suggest,^{31,41} progress to better assess pediatric patients postoperatively in the clinic and at home is required. The implementation of validated pain assessment tools in the ambulatory clinic sets the foundation for adequate pain management. Moderate-to-severe postoperative pain in children would justify appropriate management.

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