

Doctoral (PhD) thesis

**Oral health of preschool children and their dental treatment
under general anaesthesia**

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1. Introduction

Caries is a common disease representing a serious health problem worldwide. Early childhood caries (ECC) occurs in children younger than 72 months, i.e., 6 years, if caries is present in the primary dentition (including filled or extracted primary teeth due to caries). Any caries in children under the age of three is defined as severe early childhood caries (S-ECC). Between 3 to 5 years of age, it is classified as severe early childhood caries (S-ECC) if any primary tooth is decayed, filled, or missing due to caries, or if the value of def-index (decayed, extracted, filled) is higher than 5 until the age of 4, and higher than six until the age of 5.

ECC is a multifactorial disease. Etiological factors include the parents' socioeconomic status, educational level, level of health awareness and knowledge and the oral health of the parent/caregiver. In association with general health awareness, certain lifestyle and nutrition habits are determinative, such as frequent consumption of sugar-containing foods and drinks or, in case of babies and toddlers, comforting them with sugary drinks from baby bottles.

A principal element of dental prevention is reducing sugar consumption. The study by Paglia et al. showed that nutrition is the main factor leading to caries in early childhood, including the consumption along with the method of intake of refined carbohydrate. According to aetiology and progression, type I. (mild-moderate), II. (medium-severe) and III. (severe) categories are distinguished. Type I ECC is isolated caries on the incisor or molar tooth surface, caused by semi-hard or hard food and poor oral hygiene. In ECC type II. the upper incisors are affected, and caries may also occur on the buccal surface of the molar teeth, but the lower incisors are typically healthy. The main etiological factor in this case is the frequently taken cariogenic drinks, e.g., sugar-containing liquid from baby bottle or breastfeeding on demand, even with good oral hygiene. In type III., almost all primary teeth can become affected due to a cariogenic diet and poor oral hygiene.

The next step in prevention is to support oral health awareness of parents/caregivers. With appropriate education, a positive behavioural pattern can be established in the family at an early age that contributes to the child's entire life. According to the Hungarian law currently in force (Decree 26/1997. (IX. 3.) of the Ministry of Public Welfare on school health care), regular dental screenings for children are conducted from the age of three organized by the educational institution attended. During the first 3 years, children are "invisible" to the dental health system. Dentist-parent communication supporting oral health, and in several cases, the early recognition and treatment of pathological changes cannot be achieved. The AAPD recommendation, on the

other hand, calls for the first dental visit to take place between the first erupting tooth and the child's first birthday.

Dental treatment in young children, especially under the age of 3, is extremely time-consuming and difficult to implement. In many cases, it is not possible to provide definitive or any care at all in outpatient settings, some treatments can only be performed under general anaesthesia. Dental interventions under general anaesthesia (DTGA) nowadays are routinely and safely performed, mortality or serious postoperative morbidity is rare. Nevertheless, several complications and complaints are associated with the dental treatment or with general anaesthesia, such as: pain, bleeding, nausea, vomiting, etc.

2. Aims of our study

1. To assess the oral health status of children younger than 36 months of age in nurseries of Pécs.
2. To study whether parents received information on their child's oral health from a healthcare specialist and, if so, how this influenced the child's oral hygiene habits, nutrition, and caries prevalence.
3. To examine the postoperative complaints of children undergoing DTGA. The intraoperative and postoperative pain management found in the literature show significant clinical heterogeneity, therefore further investigation of the factors influencing pain is necessary.
4. Examining the prevalence of postoperative complaints other than pain. We aim to reveal correlations that may help improve defining effective treatment guidelines.

3. Patients and Methods

3.1. Dental screening

Children's dental screening was performed in all nurseries maintained by the Social Institutions for Children of the Pécs County Municipality and in the nursery operated by the Faculty of Medicine of the University of Pécs (Ethical license number: PTE/75208/2018). Dental screening took place in the nursery on a pre-arranged appointment. The screening was performed before breakfast, if possible, after the children brushed their teeth at home. The light source was provided by headlamps and disposable dental mirrors were used for the examination, optimizing the available out of office circumstances. Two dentists performed the examination on all children in the study. Dental nurses manually recorded the results on the dental status sheets used in daily practice. The teeth were evaluated according to the standardized, internationally accepted International Caries Classification and Management System (ICCMS). To ensure the reliability of the examination, the dentists assessed the children's dental condition after completing the self-assessment test of the ICCMS e-learning online training. Teeth were considered decayed if a lesion with a value of 3 or higher was diagnosed. Recording a value of 1 or 2 according to the ICCMS, i.e., incipient (reversible) caries, would have been misleading considering the circumstances of the examination. In the present study, values 3-6 according to the ICCMS were not separated from each other since invasive dental treatment is already justified in these cases. Of the children participating in the screening, all collected children aged 36 months or younger were statistically evaluated in our study.

In our epidemiological study, the decayed-filled-index (df-index), the modified df-index (m-df-index) introduced by our research group, which can be applied to partially erupted primary dentition, the Significant caries index (SiC), the Care Index (CI) and the Restorative Index (RI) were calculated.

3.1.1. Parent questionnaire related to dental screening

A questionnaire was compiled for the parents of the children participating in the dental screening. After personal data, questions about the child's nutrition were asked. For the pre-given answers, the most frequently consumed, harmful to teeth, and tooth friendly options were listed. The third part assessed the oral health awareness of parents, partly with questions to be

decided, and partly, with the option of providing answers in own words. Then, after questions assessing the importance of oral hygiene, parents' highest level of education evaluated.

3.1.2. Statistical analysis

Statistical analysis was performed using the SPSS Statistics 24 software (BM Corp, Armonk, NY, USA). Correlations between children's dental status and parents' responses were evaluated. Possible differences in the caries prevalence of children between informed and non-informed parents were investigated using Mann-Whitney test. Chi-square test was performed to investigate whether acquired information about oral health changes the sugar content of regularly consumed drinks. When evaluating the method of regular fluid intake, we divided the examined group into two categories: a group using favourable methods from the dental point of view (did not use a baby bottle), and a group that also used a baby bottle. The statistical analysis was performed using Chi-square test. Chi-square test was also used to investigate whether the feeding method in the first 6 months influenced the fluid intake method chosen during weening and later. Kruskal-Wallis test was used to examine the relationship between the parent's highest educational level and caries frequency. The results were considered statistically significant at $p < 0.05$.

3.2. Postoperative complaints of children undergoing DTGA

Our cross-sectional observational study (Ethical license number: 6823-PTE 2018) was carried out at our division (Paediatric Dentistry, Department of Dentistry, Oral and Maxillofacial Surgery, Medical School and Clinical Centre, University of Pecs, Hungary). All patients included in the study were assigned to ASA Class 1. After surgery, patients were monitored in the ward for at least 6 h before discharge (observation period). Questionnaires were returned to the office seven days later, at the follow-up appointment.

3.2.1. Children's questionnaire: Wong-Baker Faces Pain Rating Scale (WBS)

The children received a standard Wong-Baker FACES® Pain Rating Scale (WBS) questionnaire for pain evaluation on a scale from 0 to 10 (wongbakerfaces.org). To determine the baseline pain (before premedication and surgery), we explained the scale to the children and

asked them to color the first WBS figure. After DTGA, WBS was filled in during hospitalisation (right after awakening and 3 hours and 6 hours later) and once a day for the following 7 days.

3.2.2. Parent questionnaire related to DTGA

A dichotomous answer sheet was provided to the parents to be filled in at the same time as the WBS. Pain-related and non-pain related postoperative complaints (bleeding, coughing, nausea, vomiting, numbness, difficult awakening, sleep disturbance, drowsiness, swelling, eating difficulty, fever, etc.) were included.

3.2.3. Data collection

Parameters that may influence postoperative complaints were collected from a consistently applied medical record. These included age, gender, length of surgery, airway device (laryngeal mask airway-LMA, nasotracheal intubation-NTI), number and forms of dental interventions and the use of preoperative, intraoperative, and postoperative medications. The sample was divided into extraction (tooth extraction was also performed) and non-extraction (only restorative treatment was performed) groups. Intraoperative systemic and local analgesia (LA) antibiotics (AB) and local antihemorrhagic treatment (with absorbable suture) were used only in extraction cases at the operating team's discretion. Patients and parents were not informed of the intraoperative medications administered. Statistical analysis was performed by comparing the answers of the questionnaires against the records of the interventions.

3.2.4. Statistical analysis

The analysis was performed using SPSS (IBM Corporation, Armonk, USA, v25.0). Oral pain reported by children and guardians was analysed for all cases and for extraction cases separately. Owing to the non-normal distribution of the data, all analyses were carried out with non-parametric tests: Mann-Whitney U-test was used to compare differences between two groups, while Kruskal-Wallis tests with Mann-Whitney post hoc analysis and Bonferroni type 1 error correction were applied in cases of several groups. Spearman's rho correlation analysis, chi-square tests, or Fisher tests were used to examine correlations between two variables.

McNemar's test was used to examine the overlap between the presence of pain reported by parents/guardians and children. Results were considered statistically significant if $p < 0.05$.

4. Results

4.1.1. Evaluation of the dental screening

In our study, three hundred and sixty-two children aged 36 months or younger underwent dental screening. The caries prevalence was 15.46%, average age was 28.49 ± 5.25 months, gender distribution: 186 girls, 176 boys. Carious teeth were found in fifty-six cases (gender distribution: 25 girls, 31 boys). The df-t index of the population was 0.685 ± 2.20 . In case of one child, the df-t-index reached 20, the maximum value, meaning that all teeth of the fully erupted primary dentition were carious. The average number of erupted primary teeth was 18.06. The m-df-t index modified by the number of erupted teeth was 0.758 ± 2.42 , since only 58.9% of the children (214 cases) had fully erupted primary dentition at the time of screening. Caries was confirmed in 4.01% (248) of the 6045 examined teeth. The value of the SiC-index was 2.06 ± 3.33 . In 119 cases, caries was localized only on the upper incisors, and in 80 cases only on the lower and upper primary molars. Co-occurring incisor and molar involvement were detectable in 163 cases. In 6% of the children the lower incisors were also carious (S-ECC III.) In the studied population no treated, i.e., filled or extracted teeth due to caries were found (CI=0%, RI= 0%), 100% of the children's df-index is given by the "d" component.

4.1.2. Evaluation of the parent questionnaire related to dental screening

The questionnaire was completed in and returned for evaluation by 306 parents. Fifty-six parents (15.46%) agreed to participate in the dental screening but did not return the questionnaire. The respondents emphasized the importance of oral hygiene in all cases, therefore the answers to this question were not considered in the subsequent statistical evaluation. During pregnancy, 150 parents (49%) received oral health information from a health professional (nurse, doctor, dentist). Sixty-eight parents (45.3%) received oral hygiene instructions, 16 of them (10.6%) received information on both nutrition and oral hygiene, and in 5 cases (3.3%) only the importance of the child's dental screening was drawn to attention. In sixty-five cases (43%), the respondents did not complete the text response option. Due to the

low number of cases, these answers of the questionnaire could not be statistically compared against the cariological status.

There was no significant difference regarding the number of carious teeth in case of children whose parents received dental prevention information and of those that did not ($p=0.196$). By comparing “information received” with the sugar content of regularly consumed drinks, it can be determined that 19.5% of those who received information and 29.5% of those who did not, regularly gave water to their children. Comparing the favourable/unfavourable drinking habits from a dental point of view, no statistically significant difference was shown in relation to receiving/ not receiving information ($p=0.453$). When examining the method of drinking and caries frequency, caries was more common in bottle fed children than in the others. A significant difference could not be verified, but a trend could be detected ($p=0.069$).

A significant difference was found regarding the initial feeding of the newborn/infant and the method of subsequent liquid consumption. Only 31.9% of parents of exclusively breastfed children chose bottle feeding, in contrast to 71.2% of parents of formula-fed children and 61.9% of parents of mixed fed (formula- and breastfed) children ($p<0.001$).

Regarding the type of the liquid, water is the consistently offered drink for 75% of breastfed children, while this ratio is only 52% for formula-fed children ($p=0.170$).

We assessed the parents' level of highest education in the studied population. In case of mothers, tertiary education was the most common (57.9%, primary education: 5.3%, secondary education: 36.8%), while for fathers, secondary education had the highest proportion (49.5%, primary education: 5.4 %, higher education: 45.1%). The relationship between the highest level of education for each parent and the child's caries frequency was examined. The mother's educational level showed a significant positive correlation with the prevalence of caries. The higher was the educational level of the mother, the healthier were the child's teeth ($p=0.015$). Children of parents completed primary education had caries in 25%, carious lesions were found in 18.9% of children of parents after secondary education, while in children of parents with tertiary education this rate was 11.8% (difference between tertiary and secondary education: $p=0.470$; between tertiary and primary education: $p=0.004$; between secondary and primary education: $p=0.012$). Children of mothers completing primary education had nearly 3.5 times as many caries as children of mothers after secondary education, and the caries frequency was about nine times that of children of parents after tertiary education. A trend was detected between fathers' educational level and their children's caries frequency ($p=0.088$).

Drinking from cup was the highest among children with mothers after tertiary education, this rate decreased simultaneously with lower education levels (higher education: 66.7%, secondary

education: 41.3%, primary education: 31.3%; $p=0.009$). No significant correlation could be found in case of fathers ($p=0.199$). A significant correlation was shown between the parents' highest educational level and the type of liquid offered for consumption. A higher level of education for both the mother ($p=0.028$) and the father ($p=0.05$) is associated with an increase in the proportion of water consumption and a decrease in the proportion of sugary liquid. Mothers with tertiary education breastfed their children in the highest proportion (tertiary education: 53.4%, secondary education: 34.2%, primary education: 37.5%; $p=0.006$) in the first six months. Our investigation did not cover other sociological and socioeconomic aspects.

4.2.1. Results of postoperative examination of children treated under general anaesthesia

During the study period, 368 children were treated under GA in our clinic. Two hundred and thirteen were excluded due to the presence of an underlying disease, age over 18, or refusal to participate in the study. Out of a sample of 155 people, 52 did not return the questionnaire for the control examination or missed the control appointment. Thus, 103 children treated under general anaesthesia (average age: 5.07 ± 2.55 years, gender distribution: 44 girls, 59 boys) were included in our study. No significant interoperator variability was observed. Of the 103 WBS questionnaires, three were not returned or were partially completed; therefore, 100 questionnaires were deemed suitable for further evaluation. During hospitalization, 98% of the patients reported some kind of postoperative complaint.

4.2.2. Evaluation of children's questionnaire

The prevalence of pain (regardless of severity) was 38% preoperatively and 66% in the postoperative observation period. The frequency of pain (regardless of severity) during the postoperative week decreased continuously from 43% to 6%. Regarding unalterable factors (age, gender), there was significant positive correlation in case of one variable: increasing age correlated positively with the duration of pain in days ($p=0.04$) and with the average severity of pain during the postoperative week ($p=0.04$) among all cases. A significant positive correlation was found between the duration of the operation and the severity (all: $p=0.01$; extraction: $p<0.01$) and duration of pain during the postoperative week (all: $p<0.01$; extraction: $p<0.01$). A positive correlation was also revealed between the age and the duration of the intervention ($p<0.01$). The airway management showed a significant positive correlation with the duration and intensity of pain experienced in the postoperative week. Compared to LMA,

NTI was associated with significantly longer (all: $p=0.02$; extraction: $p=0.02$) and more severe (all: $p=0.02$; extraction: $p=0.02$) pain during the postoperative week. Administering LA during the operation did not influence pain (frequency: $p=0.67$; severity: $p=0.14$) during hospitalisation. Surprisingly, 16% of the children who did not receive LA complained about numbness. While the class and number of primary tooth extractions (anterior, molar, or both) did not affect the duration of pain ($p=0.06$ and $p=0.78$ respectively), the average severity of pain during the postoperative week was significantly lower ($p=0.03$) in cases where only anterior tooth extractions were performed. The severity of pain during hospitalisation was significantly lower in cases where opioids were administered intravenously (all: $p=0.02$; extraction: $p=0.04$). NSAIDs did not significantly affect the severity of pain (all: $p=0.74$; extraction: $p=0.78$). The severity of pain during hospitalisation positively correlated with the duration (all: $p<0.01$; extraction: $p<0.01$) and severity of pain in the postoperative week (all: $p<0.01$; extraction: $p<0.01$). The average severity of pain was the highest after the intervention compared to baseline pain ($p=0.014$), and it gradually decreased during the postoperative week. The average pain score declined below the average initial pain sensation on the second postoperative day. The severity of pain during hospitalisation was significantly higher than baseline pain ($p=0.01$). On the first 4 days, patients did not experience a significant difference in the pain level compared to the baseline pain ($p=1.00$ for days 1–3, and $p=0.22$, day 4). A significantly lower average pain was reported from the fifth day onwards (day 5, $p=0.01$; day 6, $p<0.01$; day 7, $p<0.01$). Furthermore, the severity of pain on day 1 was not significantly different from that recorded during hospitalisation ($p=0.37$). From day 2 onwards, it significantly declined (day 2, $p<0.01$; day 3–7, $p<0.01$).

4.2.3. Parent questionnaire related to DTGA: pain-related complaints

During hospitalisation oral pain was reported in 33% of all cases, but there was no significant difference between the extraction and non-extraction cases ($p=0.21$). 15,5% of patients had oral pain solely. Oral pain positively correlated with age (all, $p<0.01$; extraction, $p=0.01$) and duration of treatment (all: $p=0.01$; extraction: $p=0.02$). The administration of LA did not affect the frequency of pain ($p=0.25$). During the postoperative week, 31% of the parents reported pain (regardless of duration). Significantly more prolonged pain was reported in females (all: $p=0.01$; extraction: $p<0.01$). Sore throat reported during hospitalisation (30%) positively correlated with age (all: $p<0.01$) and length of treatment (all: $p=0.01$). In 11 cases, sore throat was the only reported pain. Nasal pain reported during hospitalisation (10%) positively

correlated with age (all: $p=0.02$). One responder reported nasal pain only, which may have originated from the NTI. Nasal-throat pain and nasal-oral pain were reported in 2 cases each, and oral-throat pain occurred in 10 cases. All three areas were affected in 6 cases.

The frequency of postoperative pain reported by parents and children was significantly different during hospitalisation for all cases ($p<0.01$) and extraction cases ($p<0.01$). Among all cases, 42 pairs of parents and children did not agree regarding the presence of pain. Parents reported pain less frequently than children: 37 children reported pain when their parents did not. For extraction cases, 38 disagreements were found; in 33 cases the child reported pain and the parent did not.

4.2.4. Parent questionnaire related to DTGA: non-pain-related complaints

Oral bleeding was analysed among extraction cases. During the hospitalisation period (81.7%) it showed significant positive correlation with age ($p=0.02$), duration of surgery ($p=0.04$) and number of primary tooth extractions ($p=0.007$). During the postoperative week oral bleeding (13.9%) showed positive correlation with the number of extracted primary teeth ($p=0.045$). Since oral bleeding in the postoperative week was present only in a limited number of cases and for a short time, duration could not be used in statistical analysis.

Nasal bleeding (epistaxis) during hospitalisation was reported in 21.3% of the cases. Parents did not report nasal bleeding during the postoperative week. Cough during hospitalisation was reported in 42.7% of the cases. Emergence agitation was registered in 28 cases.

Nausea and vomiting were separately asked in the questionnaire, but since nausea is difficult to define to children, it was omitted from the analysis. Vomiting was reported in 57.2%. Its frequency showed positive correlation exclusively with age ($p=0.001$). The postoperative use of ondansetron did not affect the presence of vomiting ($p=0.244$).

Postoperative sleep disturbance was found in 13.5%. that subsided by the 6th postoperative day. Due to the limited occurrence, duration could not be used for statistical analysis.

Drowsiness was reported in 86.4% (89) of the cases during hospitalisation and in 21.3% during postoperative week. Its longest reported duration was 2 days.

5. Discussion

Caries was confirmed in more than 15% of the 362 children examined by our research group. The df-index of the studied population is 0.685, however, due to the age characteristics, some of the children has not yet had fully erupted primary dentition. The modified df-index (0.758) proposed by our research group more accurately reflects on the actual dental status of the sample group. Since component “d” accounts for 100% of the df-index (no treated teeth were found), and considering the circumstances of the examination, the teeth were registered as carious from ICDAS 3, therefore invasive dental treatment would be justified for all affected children.

Calculating the SiC index evaluating the most caries-affected one-third of the studied population, the children have an average of more than two (2.02) decayed teeth.

Our results show that the CI and RI of the studied population are 0%, i.e., the children do not have teeth treated for caries (filled, extracted). In 2014, the CI among 5-year-olds was 13% in Scotland and 14% in the UK.

Our results reveal that the caries frequency of children in the informed and not informed groups is almost the same. Those who received information give a higher percentage of cariogenic drinks to their children than those who were not informed. Conclusion can be drawn that the quality or frequency of parent education is not sufficient to acquire the appropriate knowledge. There is a need for developing a dental prevention guideline that would define exactly what information parents (who are fully responsible for their child's oral health) should obtain. One-time education is not enough. In the long term, maintaining health awareness and motivation can only be achieved through effective, regular communication based on, if possible, multiple sources (paediatrician, nurse, dentist) and on unified guidelines. Studies confirm that ECC prevention should begin during pregnancy, as the mother's oral health and the early introduction to the child's oral hygiene habits are of outstanding importance in the prevention of dental diseases.

Babies exclusively breastfed in the first six months benefit in the long term, as their parents (primarily their mothers) are more likely to offer water and from a cup. However, it is important to highlight that some mothers breastfeeding long-term are not aware of breast milk being also cariogenic. Tham et al. described that the caries risk is higher in infants breastfed for more than 12 months than in those breastfed for less than a year. In addition, children who are breastfed for more than 12 months which may include nighttime as well, form a special risk group.

In the study by Szatko et al., the mother's highest level of education directly correlates with her knowledge on oral hygiene. This correlation is also reflected in our study. Children of mothers with tertiary education had the lowest caries frequency and the highest rate of drinking water from a cup. In case of mothers with primary education level the caries prevalence and the rate of offering sugary liquids were significantly higher.

According to the results of our dental screening, more than 15% of children under the age of 3 already need invasive dental care (restorative treatment or extraction). Due to children's age cooperation cannot yet be expected, and that is fundamental for outpatient treatment. Although the advantages of DTGA are indisputable, it is extremely important to inform parents and patients in advance about the type, frequency, and severity of possible postoperative complaints.

We investigated possible factors influencing pain experience in relation to unalterable (age and gender) and alterable (length of treatment, airway device, and intraoperative and postoperative pain management) parameters.

Postoperative pain was significantly more common (66%) and more intense than baseline pain. We observed longer-lasting pain during the postoperative week in patients with primary molar extractions than in patients with anterior extractions alone. Understandably, molar extractions leave a larger wound surface and require a prolonged healing time. Furthermore, by the time of primary incisor extraction, the roots can be partially or completely resorbed, resulting in shorter pain duration.

Older age showed a positive correlation with both the duration and severity of pain. In our study, it is related to the increased number of interventions with age, or it may be an individual subjective variable among patients. Needleman et al. suggested that older children require more analgesics postoperatively than younger children, which supports our results on the pain-age correlation. On the other hand, Fung et al. showed that younger age was a predictive factor for postoperative pain, and it occurred more frequently in male patients than in female patients. According to parent questionnaires, the duration of pain after DTGA was greater in females. This was not corroborated by the self-report WBS questionnaires, and it is possible that parents have different perceptions regarding the pain of their children based on their gender.

Patients experienced less severe and shorter lasting pain in the postoperative week if treatment time was shorter and/or when LMA was applied. Longer operation time may result in prolonged and increased pain. Atan et al. concluded that a reduction in treatment time has the potential to reduce postoperative pain. These findings suggest that dental professionals should decrease the duration of treatment under GA and maintain GA through a laryngeal mask instead of

nasotracheal intubation whenever possible. However, these results might be misleading, as the type of airway device used is also related to the interventions and the treatment time; these factors cannot be separated from each other. Non-oral pain, reported by parents are most likely due to NTI anaesthesia with a pharyngeal pack. The use of LMA could prevent these complaints; however, due to the incapability of isolation against aspiration and the limited access to the oral cavity, comprehensive treatment usually requires NTI.

The treatment time should be shortened by careful treatment planning, for that, where possible, a radiographic examination is recommended prior to GA. When deciding on the plan with the primary tooth many factors should be considered. Exodontia is the least expensive treatment option, as less time and equipment are required for the intervention. Moreover, a radical treatment plan may decrease the treatment time and decrease the chance of need for repeated DTGA. Nevertheless, the trend worldwide is to provide comprehensive treatment, where a wide range of restorative treatments are offered. Long-term consequences of premature primary tooth loss such as crowding, ectopic tooth eruption or impaction should also be considered.

Numerous studies support the use of LA as a supplementary medication to reduce postoperative pain, but its use remains controversial. In our study, we found that LA administration before extraction did not affect postoperative pain; however, the local numbness might be unpleasant. Those who oppose the use of LA have reported self-inflicted soft tissue trauma of the lips, cheeks, or tongue due to loss of sensation; however, we did not observe any of these injuries during follow-up appointments. The beneficial anaesthetic effect of LA or the occurrence of soft-tissue injuries may have been absent because the patients fully regained consciousness by the time the LA wore off. In addition, extractions at the site of numbness reduce the risk of soft tissue trauma. Surprisingly, 16% of the patients who did not receive LA complained of numbness. As numbness may be difficult to describe for children who have never received LA before, some of our patients might not have been able to provide reliable feedback.

In our study, the severity of pain reported by patients receiving intravenous opioid analgesics during hospitalisation was significantly lower compared to that reported by patients who received NSAIDs only. Intraoperative and postoperative medications may influence the choice of postoperative pain management. Where postoperative pain is associated with inflammation, NSAIDs are considered as first-line agents by AAPD.

Bleeding from the oral cavity after extractions is a common phenomenon regardless of the setting of the intervention (outpatient vs. day care patient). It is recommended to provide complete, comprehensive dental rehabilitation under GA to reduce the chance for retreatment. Multiple extractions may need to be carried out in a single appointment, leading to prolonged

bleeding. Bleeding positively correlated with the number of primary tooth extractions, and it was more common among younger patients during hospitalisation. The latter finding is related to the advanced physiological root resorption of primary teeth in older patients, where extraction leaves smaller wound surfaces, thus blood clot formation and stability are more ideal, resulting in less bleeding. Based on our results, administration of LA containing adrenalin during operation did not have an impact on oral bleeding. The adrenalin in LA has a local vasoconstrictor effect and results in reduced perioperative bleeding, on the contrary, the subsiding effect of the locally administered adrenalin promotes vasodilatation and bleeding. Therefore, epinephrine may mask intraoperative bleeding, but secondary bleeding can occur after the diminishing local effect. The use of LA in case of primary tooth extractions does not provide protection against postoperative bleeding and according to our previous study it does not reduce postoperative pain either.

Suturing the gingiva around the extraction socket of primary tooth for the re-approximation of retracted soft tissues and for the stabilisation of the blood cloth is well established in surgery. Suturing did not reduce the prevalence of postoperative bleeding in our study. This finding may be a result of different suturing techniques used (interrupted sutures, simple continuous sutures) or the fact that postoperative bleeding was evaluated by a non-professional observer (parent), and the extent of bleeding was not described.

The use of systemic haemostatic agent (etamsylate) is indicated in surgical interventions. Based on our results systemic administration of etamsylate had no influence on postoperative bleeding. It may play a role in intraoperative bleeding control, but in our study long-term effect could not be demonstrated. Oral bleeding during postoperative week showed positive correlation only with the number of primary teeth extracted. It affected 14% of the extraction cases and was reported by parents until the 3rd postoperative day. Parents did not seek any further medical attention; therefore, presumably only mild periodic bleeding might have occurred, possibly related to eating, toothbrushing or drinking.

Epistaxis did not show statistically significant correlation with any examined parameters. We should however acknowledge that no patient in the LMA group had nasal bleeding, whereas 23.16% prevalence was observed among patients receiving NTI. Due to the limited number of LMA cases statistical analysis could not reveal significant difference,

Cough could not be associated with any examined parameters. Interestingly, there was no significant difference in the frequency between the NTI and LMA group. This may be due to

the low case number in the LMA group, or the irritation related to NTI is truly not a significant factor resulting in coughing.

Emergence agitation was reported in 27.18% of the cases. Keles and Kocaturk reported higher incidence of emergence delirium with NTI than with LMA. In our study the prevalence did not correlate with any of the analysed parameters, therefore its prediction remains challenging. In a study, carried out by Dalens et al., nalbuphine significantly decreased the incidence and severity of emergence agitation after DTGA, without delaying discharge.

The prevalence of vomiting in our study was much higher (57.2%) compared to other studies (6.1%-35.5%). In our practice, GA is induced and maintained with sevoflurane using a rebreathing system. In the soda lime of the system sevoflurane can degrade to formaldehyde. Inhalation of formaldehyde can provoke significant nausea and vomiting. According to our findings, older age was the only predictive factor for vomiting. This is in correlation with other clinical trials, where toddlers were found to be less susceptible to emetic stimuli, than older children. Over the age of 3 years the risk for vomiting increases. Opioid analgesics can be major risk factors for postoperative vomiting. In our study, the prevalence of vomiting was higher in patients receiving nalbuphine solely (54%) or in combination with fentanyl (71%) compared to patients receiving only fentanyl (37.5%) or no intraoperative systemic analgesia (28.57%). Further studies are needed to assess this matter.

Sleeping difficulty during postoperative week was reported in 13.59% of the cases. It did not correlate with any of our examined parameters.

Drowsiness during hospitalisation was the most reported complaint (86%). We found association with the administration of opioid analgesics. Simultaneous intraoperative use of fentanyl and nalbuphine showed the highest incidence (92%), followed by nalbuphine only (90%), fentanyl only (75%) and no intraoperative systemic analgesic groups (42.86%). Drowsiness during hospitalisation is not necessarily an adverse event if it does not interfere with the time of discharge. Although we did not find significant correlation with the examined parameters, according to Steinmetz et al., patients having longer operations are at higher risk of developing drowsiness, indicating the role of the elongated sevoflurane inhalation. Drowsiness during postoperative week was also reported in 21.36%, but its frequency did not correlate with any examined parameters.

Facial swelling (17.48%) positively correlated with the number of primary tooth extractions, suggesting that more invasive interventions increase the chance of inflammation. Contrary to

the study by Martín-Ares et al., facial swelling was significantly more common among patients who received antibiotics (amoxicillin-clavulanic acid) during operation and the postoperative week. In our study antibiotics were administered in cases where multiple extractions were carried out leaving extended open wounds to prevent superinfection during the healing period. These results suggest that the number of tooth extractions is the primary risk factor of postoperative facial swelling. Administration of antibiotics may not have direct impact on the occurrence. Based on the parent questionnaire, none of the patients with facial swelling required medical care related to this complaint. At the follow-up appointment no signs of superinfection were detected. According to the parent's description only mild, temporary local swelling was observed.

Eating difficulty during postoperative week was reported in 37.86% of the cases. Older age, numerous primary tooth extractions showed positive correlation with this parameter. Patients without extractions or undergoing only anterior extractions had a lower frequency of eating difficulty (21.43% and 14.29% respectively) than those with molar extractions (38.24%). The highest prevalence was found in cases where both front and molar teeth were extracted (51.22%) ($p=0.045$). The latter result partially overlaps with our findings about the number of extractions. In a recent study inability to eat in the first postoperative day was reported in almost 25% of the cases following DTGA, also related to the number of teeth extracted. In our study, children with eating difficulty reported more severe and longer lasting pain during the postoperative week, highlighting the importance of pain management during this period.

6. A summary of our new findings and results

1. The m-df-index: Although df-index is a widely used dental epidemiological indicator, when applied to partially erupted primary dentition it positively distorts the dental status. The modified index proposed by our research group more accurately represents the caries prevalence of the preschool age group.
2. Caries prevalence of the 36-month-old or younger in Hungary has not been surveyed until the publication of our study in 2021, and there are only a few publications on the subject in international literature. Examining this age group is of particular importance, since the prevalence of caries is still rising in the primary dentition. Due to the lack of cooperation, dental treatment for children is only feasible with special personal and infrastructural background (general anaesthesia), access to that is limited in our country. For this reason, the systemic and effective reform of comprehensive dental prevention becomes even more important.
3. The assessment of children's postoperative pain based on self-report is difficult in the examined age group, medical personnel often rely on the judgment of the parent. Our study shows that there is no complete agreement when comparing the child's and parent's perception of pain, and the child's pain is sometimes under- or overrated by their parent.
4. LA applied intraoperatively in general anaesthesia does not reduce the frequency or intensity of postoperative pain in case of primary tooth extraction.
5. The epinephrine-containing LA used intraoperatively in general anaesthesia does not prevent postoperative bleeding in case of primary tooth extraction.
6. Our study showed an exceptionally high incidence of postoperative vomiting compared to data found in literature. It appears appropriate to re-evaluate and transform the anesthesiologic methods used at our clinic.

7. List of Publications

7.1 Publications related to the thesis

Radácsi A, Dergez T, Csabai L, Stáczér N, Katona K, Szántó I, Sándor B: A súlyos korai gyermekkori fogszuvasodás előfordulása és összefüggései pécsi bölcsődések között [Prevalence and correlation of severe early childhood caries among preschool children in Pécs] *Orv Hetil* 2021;162(22):861-869. **Q4; IF (2021): 0,707**

Radacsi A, Katona K, Farkas N, Kovesi T, Szanto I, Sandor B. Pain-related complaints of paediatric patients after dental treatment under general anaesthesia. *Eur J Paediatr Dent*. 2023;24(1):61-68. **Q1; IF (2023): 3,6** shared first author: 1,8

Radacsi A, Katona K, Farkas N, Kovesi T, Szanto I, Sandor B. Nonpain-related complaints of paediatric patients after dental treatment under general anaesthesia (elfogadva) *Eur J Paediatr Dent*. **Q1; IF (2023): 3,6** shared first author: 1,8

7.2. Publications not related to the thesis

Chalas R, Mikul'áková WB, Maksymiuk P, Skawińska-Bednarczyk A, Hudáková L, Pietrak J, Andraščíková L, Zubrzycka J, Jordán D, **Radácsi A**, et al. Are Teachers Working with Visually Impaired Children Prepared to Be Advocates of Oral Health? Pilot Study. *Children*. 2023; 10(7):1235. **Q2; IF (2022): 2,44**

Somoskovi I, Radnai M, Ohrbach R, Dergez T, Tiringner I, **Radacsi A**, Nagy A: The associations between temporomandibular pain and biobehavioral variables in dental students in response to an external stressor (under publication) *J Oral Facial Pain Headache*. **Q2; IF (2023): 2,5**

Somoskövi I, **Radácsi A**, Nagy Á, Radnai M: A Diagnostic Criteria for Temporomandibular Disorders (DC/TMD) magyar nyelvű változatának létrehozása [Developing the Hungarian version of the Diagnostic Criteria for Temporomandibular Disorders (DC/TMD)] *Fogorvosi Szemle* 2018;111:2:44-51. **Q4**

Somoskövi I, Radnai M, Dergez T, **Radácsi A**, Tiringner I, Nagy Á: A depresszió és a szorongás, valamint a temporomandibularis diszfunkció feltételezett összefüggésének vizsgálata [Evaluation of the suspected relationship between anxiety, depression and temporomandibular disfunction] *Fogorvosi Szemle* 2020;113:2:57-66. **Q4**

Radácsi A, Csabai L, Somorjai Á, Katzenbach J, Szóke J: Orálhygiénés nevelési program látássérült gyermekek részére. A projekt rövid története. Szakmai beszámoló. *Magy Fogorv* 2023;23:3:151-154.

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