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Effect of ice popsicle treatment on emergence agitation in children undergoing oral surgery with sevoflurane anaesthesia: A prospective randomized controlled study

Hui-Hong Liang, MM, RN^a, You-Wei Lu, MM, RN^a, Xing-Xu Ou, MD^b, Hui Shi, PhD^c,
Ying-Jun She, MD^b, Mei-Xue Zhang, MM, RN^{a,*}

^aDepartment of Anaesthesiology and Operation Room Nursing, Guangzhou Women and Children's Medical Centre, Guangzhou Medical University, 9 Jinsui Road, Guangzhou 510623, China
^bDepartment of Anaesthesiology and Perioperative Medicine, Guangzhou Women and Children's Medical Centre, Guangzhou Medical University, 9 Jinsui Road, Guangzhou 510623, China
^cInstitute of Paediatrics, Guangzhou Women and Children's Medical Centre, Guangzhou Medical University, 9 Jinsui Road, Guangzhou 510623, China

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ABSTRACT

Purpose: Emergence agitation is a common postoperative complication during recovery in children. The purpose of this study is to explore whether the use of ice popsicle could prevent emergence agitation in children undergoing oral surgery with sevoflurane anaesthesia.

Design and methods: In this prospective randomized controlled study, 100 children undergoing oral surgery were randomly assigned to Group 1 which received ice popsicle after emergence (intervention, $n = 50$) or Group 2 which received verbal encouragement from their parents (control, $n = 50$). The primary outcome was the 2-hour postoperative incidence of EA.

Results: Group 1 had a significant lower incidence of emergence agitation (22% vs 58%, $P < 0.001$) compared with Group 2. The mean agitation score was significantly lower in Group 1 vs Group 2 at 10 minutes (1.64 vs 2.12, $P = 0.024$) and 20 min (1.60 vs 2.14, $P = 0.004$) after emergence. The peak agitation and pain scores were significantly lower in Group 1 than in Group 2 ($P < 0.001$).

Conclusions: Findings from this study suggest that ice popsicle is an effective, cheap, pleasurable, and easily administered method for alleviating emergence agitation in paediatric patients after oral surgery under general anaesthesia. These results are worthy of confirmation in other surgeries.

Practice implications: This approach is highly accepted by both children and their parents, and our findings support the effectiveness of ice popsicle in relieving emergence agitation and pain after oral surgery in children.

Clinical trials registration: Chinese Clinical Trial Registry, ChiCTR1800015634.

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Introduction

Emergence agitation (EA) is one of the most significant challenges and causes of dissatisfaction amongst parents and healthcare workers (Menser & Smith, 2020). Emergence agitation is characterized by irritability, disorientation, excitement, and inappropriate behavior, manifesting as a mental state in which there is a lack of connection between the patient's behavior and consciousness, and mostly occurs in preschool-aged children during recovery from general anaesthesia (Mason, 2017). Emergence agitation may lead to bleeding of surgical site, removal of intravenous catheters, extra nursing care, patient injury,

delaying of discharge and worrying of parents (Moore & Angheliescu, 2017). Moreover, it is associated with an increased incidence of postoperative maladaptive behaviours (Zainal Abidin et al., 2021). The prevalence of EA varies from 25% to 80% in children depending on the age, type of surgery, anaesthetic technique, adjunct medication, preoperative anxiety, and evaluation criteria (Gil Mayo et al., 2022; Mason, 2017).

Ambulatory oral surgery is one of the most commonly performed day surgeries in children, and the demand for comfortable general anaesthesia is increasing gradually (Jiang et al., 2020). Children usually experience an uncomfortable feeling and can not express it clearly after oral treatment (Muppa et al., 2013). Therefore, high-quality general anaesthesia is required. Sevoflurane anaesthesia is the first choice for oral surgery in children due to its many advantages, including a low blood/gas partition coefficient, rapid induction and recovery, easy regulation of anaesthesia depth, minimal liver and kidney side effects, and

Abbreviations: EA, Emergence agitation; FLACC, Face, Legs, Activity, Cry, and Consolability scale; SD, standard deviation; CI, confidence interval; OR, odds ratio.

* Corresponding author.

E-mail address: 13710665765@163.com (M.-X. Zhang).

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stable hemodynamics (Erb et al., 2001). However, inhaled anaesthetic agents, such as sevoflurane and desflurane, have been associated with a high incidence of EA (Costi et al., 2014; Cui et al., 2020; Yang et al., 2022), particularly in oral surgery (Costi et al., 2014; Jooma et al., 2020).

Additional assistance or pharmacological therapy is needed to prevent the occurrence of EA in children after ambulatory oral surgery (Huang et al., 2022). Numerous pharmaceutical interventions, such as midazolam, dexmedetomidine, and propofol, have been used to prevent or treat EA in children (Kawai et al., 2019; Lei et al., 2022; Xiao et al., 2022). However, pharmaceutical interventions have been documented leading to side effects, including vomiting, respiratory depression, delayed awakening, and prolonged recovery time (Lei et al., 2022; Ng et al., 2019; Xu et al., 2022). Non-pharmacologic interventions, such as the application of cold liquids or foods, have been used to treat the discomfort after oral surgery in children (Belli et al., 2009; Zandi et al., 2016). Ice popsicle has been considered an inexpensive treatment method for relieving pain and discomfort without medication, and pain has been considered as a major risk factor for EA (Ram et al., 2006; Ram et al., 2010; Sylvester et al., 2011). However, there is no report on the use of ice popsicle for EA prevention in children. We hypothesised that ice popsicle would reduce the incidence of EA in children after oral surgery. Therefore, this study aimed to assess whether ice popsicle, provided immediately after oral surgery, could reduce the incidence of EA in children.

Material and methods

Patient enrolment

Enrolled patients comprised exclusively children aged 1 to 10 years, classified as American Society of Anaesthesiologists physical status class I or II, and undergoing lingual frenectomy or excision of oral mucocoele with sevoflurane anaesthesia. The exclusion criteria were as follows: developmental delay; a history of upper respiratory infection during the preoperative 2 weeks; a known history of neurological, neuromuscular, liver, kidney, or cardiac diseases; known allergy or adverse reactions to systemic anesthetics or any ingredients in the ice popsicle; refusal to accept the ice popsicle treatment; use of sedative or analgesic drugs for more than three days; and the presence of a malignant disease.

Procedures

Blood pressure, electrocardiography, respiratory rate, and peripheral oxygen saturation were monitored routinely after admission. Induction was achieved by administering 6% sevoflurane (Maruishi Pharmaceutical Co., Ltd., Osaka, Japan) with pure oxygen at a gas flow of 6 L·min⁻¹ with a full facial mask. After the loss of consciousness, venous access was established. Subsequently, 3 mg·kg⁻¹ propofol (AstraZeneca, London, UK) and 0.01 mg·kg⁻¹ penehyclidine hydrochloride (Chengdu List Pharmaceutical Co., Ltd., Chengdu, China) were administered intravenously. A nasal cannula with a capnography line (Hudson RCI, Teleflex, NC, USA) was placed into the child's nostril to deliver sevoflurane and oxygen. The nasal cannula was connected to an anaesthesia machine, and sevoflurane with 100% oxygen at a gas flow of 2 L·min⁻¹ was delivered to the child. The end-tidal sevoflurane concentration was monitored by the capnography line in the nasal cannula, aiming to maintain a range of 1% to 1.5% by adjusting the inspired sevoflurane gas concentration. We discontinued the sevoflurane and provided oxygen using a facial mask after the surgery. The modified Aldrete score was then used to evaluate postoperative recovery in children (White & Song, 1999). The modified Aldrete scoring criteria is shown in Table 1. A high score means a good awakening effect, and the total score is 10 points. Patients with scores ≥ 9 were considered fully awake and sent to the ward.

Table 1
The modified Aldrete scores.

Items	Standards	Scores
Movement	Moving arms and legs and head spontaneously or by request	2
	Moving arms or legs spontaneously or by request, restrictedly raising head spontaneously or by request	1
	Not able to move limbs or raise head	0
Breathing	Deep breathing and effective coughing, normal respiratory rate and amplitude	2
	Breathing is difficult or restricted, but spontaneous breathing is shallow and slow, and it's possible to breath through oropharyngeal airway	1
	Breathing is paused or weak, it requires respiratory therapy or assisted breathing	0
Blood pressure	Within $\pm 20\%$ before anaesthesia	2
	$\pm 20\text{--}49\%$ before anaesthesia	1
	Above $\pm 50\%$ before anaesthesia	0
Consciousness	Completely awakening, answer questions accurately	2
	Able to wake up, drowsiness	1
	No reaction	0
SpO ₂	Air breathing SpO ₂ > 92%	2
	Oxygen breathing SpO ₂ > 92%	1
	Oxygen breathing SpO ₂ < 92%	0

Intervention and assessments

The allocation sequence was based on computer-generated random numbers that were stored by an independent researcher in a sealed opaque file. The participants were allocated into the ice popsicle group which received ice popsicle after emergence (Group 1), or the control group that received verbal reassurance and encouragement from their parents (Group 2). After the operation, the independent researcher opened the sealed file and prepared the ice popsicle according to the group allocation. The assessors who were involved in outcome assessment were blinded to the anaesthesia procedure and the patient's group allocation. The anaesthesiologists, dentists, nurses, parents, and statisticians were blinded to the group allocation. After the modified Aldrete score was >9 , the patients were fully awake without any complications such as unexpected bleeding, breath holding, upper airway obstruction or laryngospasm, patients in Group 1 were immediately given ice popsicle (a flavoured ice popsicle equating to 20 mL of liquid), and patients in Group 2 were given 3 mL normal saline to moisten their lips even though they had no ice popsicle. The patients were then transferred to the ward and monitored by the assessors. Children in both groups received encouragement and verbal reassurance from their parents in the ward. Parents hugged or made physical contact with their child when they were emotional. The verbal encouragement list, which was carefully discussed by the author team, was provided to the parents as follows: (1). You are a brave child, Mom or Dad will be around to help you as much as possible; (2). Do you have any discomfort telling Mom or Dad to help you out? (3). If you are not feeling well, please keep your mood as stable as possible, Mom or Dad will reward you with what you want as much as possible when you are discharged from hospital.

Pain and agitation scale scores were carefully recorded every 10 min for the first 60 min, and subsequently at 2 h after arrival at the ward. A standard monitoring system recorded the patients' electrocardiography, pulse oximetry, and non-invasive systolic/diastolic pressure. Agitation was assessed with the Cole 5-point scale which was as follows: 1 = falling asleep peacefully; 2 = awake and calm; 3 = irritable and crying; 4 = crying and difficult to console; and 5 = severe restlessness and disorientation. A Cole 5-point scale score of ≥ 3 was defined as EA (Lei et al., 2022), and intravenous nalbuphine 0.02 mg·kg⁻¹ was administered as treatment (He et al., 2023). Severe EA was defined as a Cole 5-point scale score of ≥ 4 for longer than 5 min. Pain was assessed with the Face, Legs, Activity,

Cry, and Consolability scale (FLACC), with scores ranging from 0 to 15 (Wang et al., 2020). Ibuprofen $10 \text{ mg} \cdot \text{kg}^{-1}$ was administered orally for pain control when the evaluated pain score was >4 (Wang et al., 2020). The total administered ibuprofen and nalbuphine, and post-anaesthesia adverse events, such as postoperative nausea and vomiting, laryngospasm, and oxygen desaturation, were monitored and recorded during recovery.

Outcome measures

The primary outcome measure was the incidence of EA within 2 h after emergence. The secondary outcome measures were the agitation and pain scores during these 2 h. The recorded data included sex, age, weight, duration of surgery, anaesthesia, and post anaesthesia care unit stay, the incidence of adverse effects, and the total administered dose of nalbuphine and ibuprofen. We also recorded the systolic/diastolic pressure, heart rate, and oxygen saturation values at the different time points.

Data analysis

All data were expressed as mean (standard deviation [SD]) or count (%). Statistical analysis was performed using the SPSS software for Windows, version 24.0 (IBM Corp., Armonk, NY, USA). In our pilot study, we found that the incidence of EA was 55%. We hypothesised that the ice popsicle would reduce the incidence by 45%. Considering a power of 80% and a type I error of 5%, 48 children were required in each group; we subsequently allocated 50 patients to each group. Data were assessed for normal distribution using the Shapiro-Wilks test. Normally distributed data were analysed by one-way analysis of variance, and non-normally distributed data were analysed by the Mann-Whitney *U* test. The agitation scores at different time points were analysed with two-way analysis of variance with repeated measures using the Bonferroni method. The incidence of EA was analysed by the chi-squared test or Fisher's exact test, as appropriate. Differences with a *P*-value <0.05 were considered statistically significant.

Ethical considerations

This prospective, randomized, parallel-arm study was approved by the Institutional Review Board of Guangzhou Women and Children's Medical Centre, Guangzhou, China (IRB2018031601), and was registered with the Chinese Clinical Trial Registry (<http://www.chictr.org.cn>) in April 2018 before patient enrollment (ChiCTR1800015634). Written informed consent was obtained from the children's parents. We recruited children undergoing day oral surgery at the Guangzhou Women and Children's Medical Centre from May 2018 to May 2019. The study will follow the ethical principles outlined in the Declaration of Helsinki. The time and location of the interviews allowed them to be away from other people who may be listening to the conversation to ensure the privacy of the participants, and the use of pseudonyms in the collection and reporting of survey results ensured the confidentiality of participants. All findings were stored on a password-protected encrypted computer that only the research team could access.

Results

A CONSORT flow diagram was presented in Fig. 1. This study enrolled a total of 108 patients, of which 100 eligible patients were included in the final analysis. Eight patients were excluded for various reasons. Patient characteristics, the duration of surgery, anaesthesia and post anaesthesia care unit stay were presented in Table 2. There were no significant differences in age, weight, sex, age proportions, the type of surgery or the duration of surgery, anaesthesia, and post anaesthesia care unit stay between the groups.

The incidence of EA was 58% (29/50) in Group 2 and 22% (11/50) in Group 1, and a significant difference in incidence was found between the two groups (odds ratio [OR]: 4.896, 95% confidence interval [CI]: 2.044–11.728; $P < 0.001$). The incidence of severe EA was also higher in Group 2 than in Group 1 (22% [11/50] vs 4% [2/50]; OR: 6.769, 95% CI: 1.416–32.367; $P = 0.015$). We then conducted a more detailed age classification of the two groups to analyze the main outcome measures. The incidence of EA, peak agitation and pain scores in three different populations of 1–3 years, 4–6 years and 7–10 years old of the two groups were presented in Table 3.

In 1–3 years of age populations, the incidence of agitation was 79% in group 2, which was significantly higher than that in Group 1 which was 32% (OR: 8.093, 95% CI: 2.441–26.827; $P < 0.001$); and the incidence of severe agitation was also significantly higher in group 2 than in group 1 (28% vs 3%; OR: 10.286, 95% CI: 1.191–88.802; $P = 0.013$). There were no significant differences in the incidence of agitation and severe agitation between the two groups in both 3–6 years and 7–9 years of age populations. The incidence of EA in 1–3 years of age populations in both group 2 and 1 was significantly higher than that of 3–6 years old and 7–10 years old in each group ($P < 0.05$). The use of ice popsicles significantly reduced the peak agitation and pain scores ($P < 0.001$).

Most EA episodes in both groups occurred during the first 10 to 20 min after emergence from anaesthesia. We used the Cole 5-point scale to assess EA, and the mean agitation scores in Group 1 were significantly lower than those in Group 2 at 10 min (mean [SD], 1.64 [0.78] vs 2.12 [1.10], $P = 0.024$) and 20 min (mean [SD], 1.60 [0.76] vs 2.14 [0.99], $P = 0.004$) after arrival back at the ward (Fig. 2). In Group 2, twenty three children received nalbuphine treatment for EA (mean dose, 2.48 mg), and 2 patients received ibuprofen for pain control (mean dose, 140 mg). In Group 1, eight children received nalbuphine treatment for EA (mean dose, 2.06 mg), and none received ibuprofen treatment.

The intraoperative haemodynamic changes of both groups were shown in Fig. 3. No differences between the groups were noted for the basal, maximum, and minimum heart rate values or for the diastolic and systolic blood pressure. The groups were also similar in terms of the incidence of postoperative nausea and vomiting. None of the children experienced vomiting or nausea that required treatment, as noted by the nurse or study-blinded anaesthesia team at the day surgery unit, or laryngospasm or oxygen desaturation.

Discussion

The present study demonstrated a lower frequency of EA, lower agitation scores and postoperative pain scores in children undergoing oral surgery with general anaesthesia who consumed a postoperative ice popsicle than in those who did not consume an ice popsicle. Based on these results, the ice popsicle intervention may be an effective, inexpensive, and easily administered method of alleviating EA in paediatric patients undergoing general anaesthesia for oral surgery.

The detailed aetiology of EA is not yet clear and many factors are involved, including preoperative anxiety, pain, tissue swelling, the type of surgery, preschool age, the patient's character, the type of anaesthetic drug, and rapid awakening (Lee & Sung, 2020; Mason, 2017; Wei et al., 2021). In our study, children aged 1 to 3 years had a higher incidence of EA than other two age groups. A previous study showed similar finding with younger children having a higher incidence of EA than older children (Lei et al., 2022). Beside ages, pain is widely regarded as an important source of EA, although EA can occur when pain is fully relieved or even following a non-painful procedure (Dahmani et al., 2014). When considering the decreased incidence of EA in our study, the effects of ice popsicles might be attributed to their analgesic properties. To the best of our knowledge, there has been no study on the effects of ice popsicle on EA after general anaesthesia.

Previous studies suggested that ice popsicle is an effective and safe method of reducing postoperative pain in patients undergoing

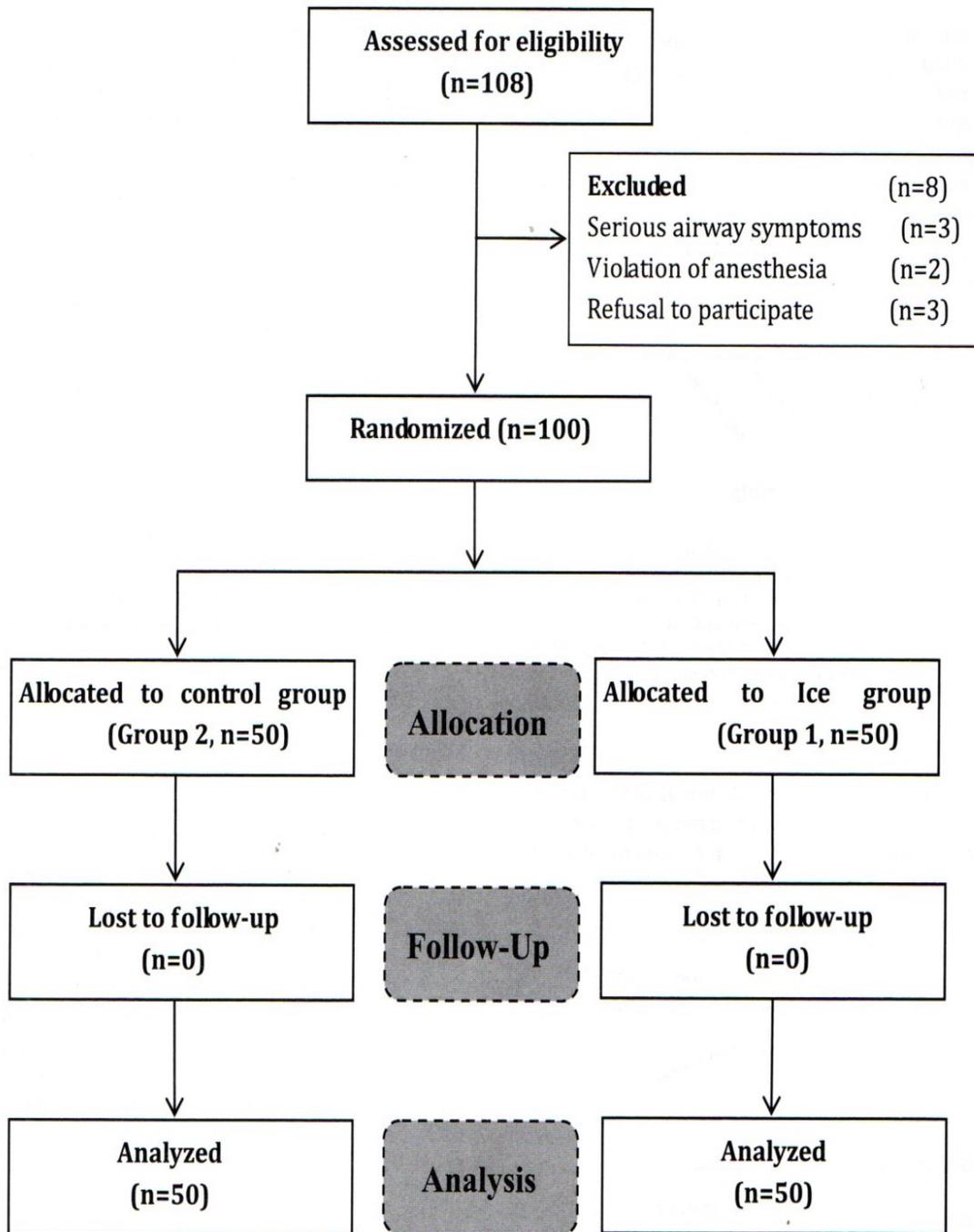


Fig. 1. CONSORT flow diagram. Microsoft Word, Office 365.

Table 2

Comparison of the children's clinical characteristics between the ice popsicle and control groups.

Item	Group 2 (n = 50)	Group 1 (n = 50)	P-value
Sex (male/female)	28/22	30/20	0.840
Age (month)	50.48 (19.95)	52.56 (15.58)	0.563
Weight (kg)	16.50 (7.47)	16.95 (5.56)	0.737
Duration of surgery (min)	11.68 (2.75)	10.90 (2.70)	0.155
Duration of anaesthesia (min)	16.46 (2.65)	15.98 (2.81)	0.382
PACU stay (min)	18.70 (3.11)	17.70 (4.54)	0.202
PONV	11 (22%)	8 (16%)	0.610
The duration of EA (min)	8.55 (2.56)	7.91 (2.07)	0.461
Age proportions			0.863
1–3 years [n(%)]	29 (58%)	28 (56%)	
4–6 years [n(%)]	18 (36%)	17 (34%)	
7–10 years [n(%)]	3 (6%)	5 (10%)	
The type of surgery			0.495
Lingual frenectomy [n(%)]	39 (78%)	35 (70%)	
Excision of oral mucocele [n(%)]	11 (22%)	15 (30%)	

Data are expressed as mean (SD) or count (%).

C, control; I, ice popsicle; PACU, post-anaesthesia care unit; PONV, postoperative nausea and vomiting; EA, emergence agitation.

Table 3

Agitation and pain scores at 2 h postoperatively between ice popsicle and control groups.

Items	Group 2 (n = 50)	Group 1 (n = 50)	P-value
Peak 5-point score	2.92 (0.94)	2.18 (0.63)	<0.001
1–3 years	3.14 (0.83)	2.29 (0.66)	<0.001
4–6 years	2.56 (0.92)	2.12 (0.60)	0.107
7–10 years	2.00 (0.00)	1.80 (0.45)	0.482
Peak FLACC score	2.26 (0.69)	1.82 (0.83)	0.002
1–3 years	2.34 (0.61)	2.00 (0.94)	0.106
4–6 years	2.17 (0.86)	1.65 (0.61)	0.048
7–10 years	2.00 (0.00)	1.40 (0.55)	0.116
Incidence of EA	29 (58%)	11 (22%)	<0.001
1–3 years [n(%)]	23 (79%)	9 (32%)	<0.001
4–6 years [n(%)]	6 (33%)	2 (12%)	0.228
7–10 years [n(%)]	0	0	/
Incidence of severe EA	11 (22%)	2 (4%)	0.015
1–3 years [n(%)]	8 (28%)	1 (3%)	0.025
4–6 years [n(%)]	3 (17%)	1 (6%)	0.603
7–10 years [n(%)]	0	0	/

Data are expressed as mean (SD) or count (%).

C, control; I, ice popsicle; FLACC, face, legs, activity, cry, and consolability; EA, emergence agitation.

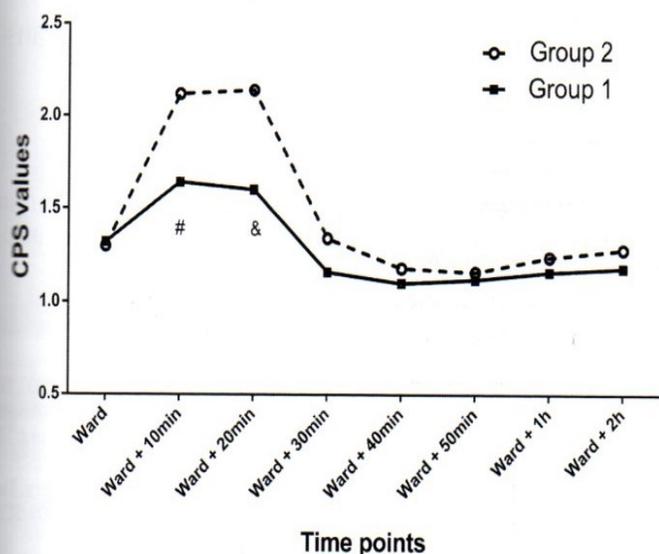


Fig. 2. Mean Cole 5-point scale scores at different time points in both groups. #: The mean agitation scores in Group 1 were significantly lower than those in Group 2 at 10 min after arrival back at the ward (mean [SD], 1.64 [0.78] vs 2.12 [1.10], $P = 0.024$). &: The mean agitation scores in Group 1 were significantly lower than those in Group 2 at 20 min after returning to the ward (mean [SD], 1.60 [0.76] vs 2.14 [0.99], $P = 0.004$). Group 1, ice popsicle group; Group 2, control group; SD, standard deviation. GraphPad Prim version 8.3.0 (GraphPad Software Inc., San Diego, CA, USA).

tonsillectomy or paediatric oral treatment (Ram et al., 2006; Ram et al., 2010; Sylvester et al., 2011). Moreover, ice compression packs have been used for some years to reduce pain and swelling after third

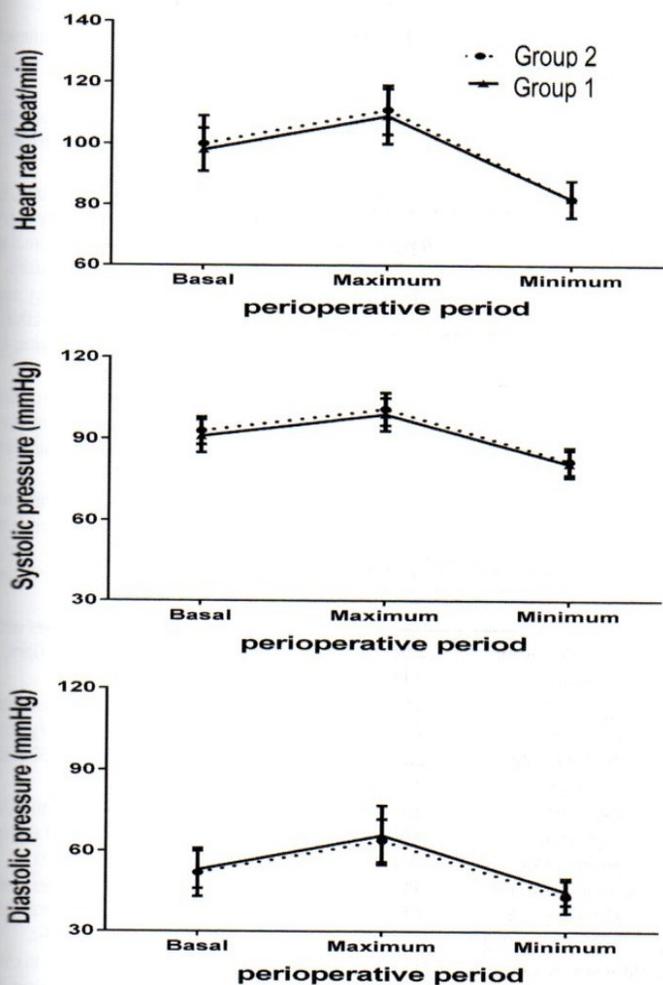


Fig. 3. Intraoperative haemodynamic changes of children in both Group 2 (control group) and Group 1 (ice popsicle group). There were no significant difference between the groups for the basal, maximum, and minimum heart rate values (A), or systolic (B) and diastolic (C) blood pressure. GraphPad Prim version 8.3.0 (GraphPad Software Inc., San Diego, CA, USA).

molar extraction and musculoskeletal injuries (Belli et al., 2009; Zandi et al., 2016). The effect of ice popsicle on pain reduction can be explained by the continuous local cold stimulation on thin non-myelinated neurons (Chidchuangchai et al., 2007). This stimulation reduces the neural stimuli transmission from the periphery, alters nerve conduction velocity, and declines muscle fibre contraction (Airaksinen et al., 2003). Cold stimuli can thus prevent tissue oedema, inhibit inflammation, slow metabolism, and control bleeding (Meloni et al., 1996).

Beside analgesic properties, both reward properties and distraction properties were also potential factors for the reduction of EA by ice popsicle in the present study. The benefits of providing children with gifts as a reward in oral clinics are widely recognized (Ram et al., 2006). Children could consider the ice popsicle as a reward in our study, which had physiological effects on soft tissue and reduced the occurrence of EA. Many non-pharmacological interventions, such as behavioural management and distraction techniques, have also been used as strategies to prevent EA (Byun et al., 2018; Gil Mayo et al., 2022; Ryu et al., 2019). Using video goggles, watching cartoons, or listening to music or their mother's voice were shown to decrease postoperative agitation in some children (Byun et al., 2018; Ryu et al., 2019). Most of these behavioural interventions can distract the child's attention from the uncomfortable feeling after surgery. There were studies suggesting that distraction may help decrease agitation and pain (Hoe et al., 2017; Levay et al., 2023). In our study, the ice popsicle, as a reward, may also have the effect of distracting the children from the postoperative agitation and pain. Hence, reward and distraction properties of ice popsicle potentially contribute to the reduction of EA in our study.

Ingesting an ice popsicle immediately after surgery also has additional benefits. The ice popsicle has greater efficacy for reducing the intensity of thirst, which is an intense discomfort, compared with water at room temperature in the immediate postoperative period (Conchon & Fonseca, 2018). A randomized trial in children has shown that drinking and eating within 4 h postoperatively improves the patient's mood and reduces the need for nausea medication, with no increase in vomiting compared with fasting (Radke et al., 2009). Also, a previous study found that early postoperative oral intake contributed to the reduction in postoperative opioid use and the incidence of postoperative nausea and vomiting in paediatric day case surgery (Chauvin et al., 2017). These abovementioned studies were consistent with our findings which showed that there were no significant difference between the two groups in the incidence of postoperative nausea and vomiting.

We found significantly lower agitation scores in children who consumed an ice popsicle postoperatively than in those who did not consume an ice popsicle, mainly at both 10 and 20 min after arrival back at the ward. Furthermore, most episodes of EA occurred during this timeframe in both groups. A previous study found that the analgesic effect of ice popsicle starts after 4 min, and lasts for at least 30 min (Waylonis, 1967). Another study showed that ice popsicles significantly alleviate discomfort within the first 10 min after surgery, with the effect lasting 30 min (Ram et al., 2010). Our results were in agreement with the onset and duration of the ice popsicle effects reported in these prior studies. The use of ice popsicle is an effective way to reduce pain, agitation, and discomfort after oral surgery in children.

Practice implications

Some sedative or analgesic drugs are used by anesthesiologists to effectively prevent EA in children, but parents often refuse to use them because of concerns that they are anesthetics. Also, some non-pharmacological interventions for preventing EA have been used by nurses in children. However, some non-pharmacological treatments are sometimes difficult to implement because they require special equipments, or because parents' anxiety prevent close cooperation between nurses and parents (Eijlers et al., 2019; Huett et al., 2017). This study showed that application of ice popsicle is effective in relieving

EA and pain after oral surgery in paediatric patients. Especially, eating ice popsicle is an inexpensive, effective, pleasurable and easily administered method for alleviating EA in children. For nurses, serving ice popsicle to children is a joyful, relaxing job, and the key is to provide ice popsicle to prevent EA. Hence application of ice popsicle should be used more commonly in clinic for children with oral surgery.

Limitations

Our study faced two limitations. Firstly, we did not measure the anxiety levels of the children or their parents before the operation in this study, and such anxiety was a risk factor for EA. However, we applied the principle of random assignment to reduce potential bias in EA incidence. Secondly, this study was not a double-blind controlled study. Although the assessors were unaware of group allocation, we could not guarantee that the assessors will not learn about grouping from some details. For example, the ice popsicle residue at the corner of the child's mouth and the color on the tongue could let the assessors know that the child was in the ice popsicle group.

Conclusions

We found that ice popsicle significantly reduce the incidence of EA, postoperative agitation and pain scores in children with oral surgery during the postoperative period, and our results suggest that an ice popsicle is an effective, cheap, complication-free, and easily administered method for alleviating EA in paediatric patients after oral surgery under general anaesthesia. The findings from this study support the use of ice popsicle as an alternative strategy for preventing EA in children undergoing oral surgery. These results are worthy of confirmation in other surgeries.

Credit author statement

Hui-Hong Liang conceived, designed, supervised the study, acquired funding, and reviewed and edited the manuscript.
 Conceptualization: Hui-Hong Liang, Mei-Xue Zhang, Ying-Jun She.
 Data curation: Hui-Hong Liang, You-Wei Lu.
 Formal analysis: Hui-Hong Liang, Ying-Jun She.
 Funding acquisition: Hui-Hong Liang.
 Investigation: You-Wei Lu, Ying-Jun She.
 Methodology: Hui-Hong Liang, You-Wei Lu, Hui Shi, Mei-Xue Zhang.
 Project administration: Hui-Hong Liang, Mei-Xue Zhang.
 Resources: Xing-Xu Ou, Mei-Xue Zhang.
 Software: Xing-Xu Ou, Ying-Jun She.
 Supervision: Xing-Xu Ou, Mei-Xue Zhang.
 Validation: Ying-Jun She.
 Writing-original draft: Hui-Hong Liang, Ying-Jun She.
 Writing-review & editing: Hui-Hong Liang, Hui Shi, Mei-Xue Zhang.
 You-Wei Lu conceived, designed and performed the studies.
 Xing-Xu Ou performed the studies, analysed the data and provided critical comments for the studies.
 Hui Shi reviewed and edited the studies.
 Ying-Jun She conceived, designed and performed the studies and wrote the manuscript.
 Mei-Xue Zhang conceived, designed and performed the studies and wrote the manuscript.
 All authors have seen and approved the final version of the manuscript being submitted. All authors warrant that the article is the authors' original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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