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Individual Cartoon Video for Alleviating Perioperative Anxiety and Reducing Emergence Delirium in Children: A Prospective Randomized Trial

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Title page

Individual Cartoon Video for Alleviating Perioperative Anxiety and Reducing Emergence Delirium in Children: A Prospective Randomized Trial

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Abstract

BACKGROUND: Perioperative anxiety and emergence delirium may cause a series of adverse events, which are worth investigating. Pharmacological treatments remain uncertain, while nonpharmacological treatments lack personalization and pertinence.

AIMS: The aim of this study was to determine whether an individual cartoon video is capable of alleviating perioperative anxiety and reducing emergence delirium in preschool children.

METHODS: Children between 3 and 7 years old undergoing adenoidectomy and tonsillectomy were randomly assigned to an individual cartoon video group (group V) or a control group (group C). In group V, an individual cartoon video was played throughout the whole waiting, anesthesia induction and anesthesia recovery periods. The children in group C were contacted through verbal conversation. The primary outcomes were perioperative pediatric anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS) and emergence delirium assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The secondary outcomes included cooperation during induction, postoperative pain and adverse events.

RESULTS: The mYPAS scores were comparable in the two groups (P = 0.583) at the holding area (T0), but the mYPAS scores of group V were significantly lower than those of group C at the time of entering the operating room (T1), during the induction of anesthesia (T2) and leaving the PACU (T6) (P<0.001, P<0.001, P=0.001) after intervention. The incidence of emergence delirium (PAED≥10) in group V was significantly lower than that in group C after extubation (T3) and upon arrival at the PACU (T4) (55% vs. 77.5%, P=0.033; 32.5% vs. 55%, P=0.043). We found no differences in cooperation during induction, postoperative pain or the incidence of adverse events between the groups.

CONCLUSIONS: The individual cartoon video is an effective method of alleviating perioperative anxiety and reducing the incidence of emergence delirium in children.

Ethics Approval Statement

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1))

Clinical Trial Registration Identifier

ChiCTR2200062300 (https://www.chictr.org.cn/index.aspx)

KEY WORDS： individual cartoon video；anxiety；emergence delirium；pediatrics;

What is already known about the topic?

Anxiety and emergence delirium are commonly observed in young children and cause many adverse effects.

Pharmacological treatments of anxiety and emergence delirium remain uncertain, while nonpharmacological treatments lack personalization and pertinence.

What new information this study adds?

The patients' favorite cartoon video was played as the intervention for anxiety, which will be targeted, and the effect will be maximized.

The individual cartoon video can not only alleviate perioperative anxiety, but reduce the incidence of emergence delirium in children.

How this study might affect the practice?

The patients' favorite cartoon video can be played as the intervention for anxiety and emergence delirium, which will be targeted, easy-accessed and the effect will be maximized.

Introduction

Emergence delirium (ED) is described as a complex of perceptual disturbances and psychomotor agitation in young children in the early postanesthetic period following a sevoflurane-based anesthetic[1]. Delirium may arise upon emergence from anesthesia, with a variable incidence of 10–80%[2-4]. ED can exert a negative impact on patient safety because there can be injury to the surgical site, tearing of drains or dressings, or accidental removal of intravenous catheters, which can even prolong the hospital length of stay. Therefore, reducing ED is a worthy clinical issue in pediatric anesthesia. Anxiety is a common abnormal psychological state before pediatric anesthesia and surgery. Due to their immature physical and mental development, children are often in a state of psychological stress during the perioperative period, which is defined as anxiety. It has been reported that up to 65% of children in the holding area and during the induction of anesthesia experience intense anxiety about anesthesia and surgery[5]. Severe anxiety easily causes noncompliance during anesthesia induction, severe pain and even delirium during the recovery period. Therefore, alleviating anxiety and reducing the incidence of ED in children are of great significance for ensuring perioperative safety and improving surgical prognosis.

The current clinical measures to prevent ED in children include pharmacological and nonpharmacological preventions. The preventive and therapeutic drugs commonly used are propofol, opioids, ketamine, α2 receptor agonists and benzodiazepines[6]. However, the efficacy of these drugs is not clear, and the optimal dosage is unknown. In addition, due to the immaturity of children's physical and psychological development, pharmacological treatment has side effects and potential risks, and the compliance of young children in taking medication is low. Compared with it, nonpharmacological interventions are more comfortable, safer and free of drug side effects. Nonpharmacological measures include age-appropriate preoperative education, family-centered preoperative preparation, parental company during anesthesia induction and distraction of children. Although parents' company and family-centered preoperative preparation can alleviate children's preoperative anxiety to a certain extent[7], children cannot be accompanied by their parents after entering the surgical isolation area due to the aseptic requirements. As a result, pediatric patients are often nervous and anxious, and it is hard for them to cooperate with medical staff. Preschool children usually enjoy watching cartoons. Although previous studies have suggested that cartoon videos can be a good distraction for children and may improve their preoperative anxiety and compliance with medical procedures[8, 9], the cartoon videos used in previous studies lack personalization and pertinence. The preferred cartoon videos in each age group and even in children one year apart are different. Therefore, it is difficult to ensure the same level of attraction

for the children when using impersonalized cartoon videos. Meanwhile, most previous studies have suggested that the causes of emergence and postoperative delirium are related to preoperative anxiety and that reducing preoperative anxiety can reduce the incidence of postoperative delirium. Therefore, some studies have focused only on how to reduce preoperative anxiety, while few have continued to pay attention to the anxiety of children who are awakening in the PACU[1].

Therefore, this study was performed to determine whether individual cartoon videos are capable of alleviating perioperative anxiety and reducing emergence delirium in preschool children.

Methods

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). Written consent was obtained from parents (or guardians). This single-center, randomized clinical trial was conducted from August to September 2022 in accordance with the principles of the Helsinki Declaration.

Ninety-five patients aged between 3 and 7 years with an American Society of Anesthesiologists physical status I-II and who were scheduled for their first elective adenoidectomy or adenotonsillectomy under general anesthesia were enrolled. Children having emergency surgery and those with previous anesthetic experience, developmental delays, mental retardation, sedative medication or chronic illnesses were excluded from the study.

The day before surgery, the eligible patients were visited by a trained anesthesiologist, and their general information and favorite cartoon videos were recorded. On the day of surgery, all of the patients were brought to the holding area 30 min before surgery and treated according to the group assignment. The enrolled children were randomized into two groups using a computer-generated randomization program: group V (distraction by watching an individual cartoon video) and group C (control). The patients in group V began to watch a favorite cartoon video on iPad throughout the whole waiting and anesthesia induction process. Patients in group C were contacted by the medical staff through verbal conversation to relieve their anxiety.

The surgery and anesthesia were always performed by the same professionals (two surgeons and an anesthesiologist), and standard anesthetic regimens and techniques were used for all patients. After the application of standard monitoring, including blood pressure, electrocardiography and blood oxygen saturation, inhalation anesthesia induction was performed at tidal volume, with incrementing sevoflurane up to 8% with a 50% mixture of air and oxygen (6 L/min). Peripheral IV access was obtained, and an appropriately sized laryngeal tube was inserted after a suitable anesthetic depth was obtained by the injection of propofol (2 mg/kg), sufentanil (0.2 μg/kg) and cisatracurium (0.1 mg/kg). Then, atropine (0.02 mg/kg) and dexamethasone (0.1 mg/kg) were administered, and anesthesia was maintained with remifentanil 0.2-0.3 μg/kg/min and sevoflurane 3%-5%. At the end of surgery, the children were extubated after awakening with adequate spontaneous ventilation and were transferred to the postanesthetic care unit (PACU) for observation. In group V, the individual cartoon video was continuously played in the early recovery stage until the children left the PACU and were reunited with their parents.

The primary outcomes were anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS)

and ED assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The mYPAS is a validated perioperative pediatric anxiety instrument with observational measurements of anxiety in 5 categories (activity, emotional expressivity, state of arousal, vocalization, and use of parents)[10]. Scores range from 23.33 to 100, with higher scores indicating higher levels of anxiety[11]. The mYPAS was administered at 4 time points: in the preoperative holding area (baseline, or T0), upon entering the operating room (T1), during the induction of anesthesia (T2) and upon leaving the PACU (T6). Behavior on emergence was measured using the PAED scale. The PAED scale was assessed at 4 time points: immediately after extubation (T3), on arriving in the PACU (T4), 30 min after arriving in the PACU (T5) and T6. ED was defined as PAED scores ≥10. The PAED scale was also used to measure the intensity of ED, where 0 represents no ED and 20 is the maximum intensity of ED. The induction compliance checklist (ICC) was used to assess the cooperation of the children at T2. A validated simplified 3-point scoring system for ICC [perfect (ICC = 0), moderate (ICC = 1–3), and poor (ICC ≥ 4)] was used in our trial[12]. The FLACC assessment tool was also administered to measure postoperative pain at the same time as PAED. The FLACC scale scores the pain intensity by rating five behaviors (face, legs, activity, consolability and cry) to derive a score out of 10.[13] All assessments were completed by the same trained anesthesiologist who is blinded to the group allocation. For the patients suffering from ED, the first measure was to comfort the patients with words. When this failed, the patients were treated with propofol (10-20 mg IV). If a child exhibited signs of pain with a FLACC scale **>** 4, sufentanil (0.05 μg/kg IV) was administered as rescue medication.

For the sample size calculation, we used a proportion of ED and anxiety of 50%, as reported in previously published studies[3, 5]. Therefore, 40 subjects per group would have a significance level of 5% and a power of 80% in detecting a 30% reduction in ED incidence between the groups. While anticipating a 15% dropout rate, we estimated that 46 patients were needed in each group.

SPSS 26.0 statistical software was used to statistically process and analyze the data. The measurement data conforming to the normal distribution were expressed as the mean ± standard deviation, and the comparison between the groups was performed by two independent samples t test. Enumeration data were expressed by the number of patients (percentage) [n(%)], and the comparison was made by $\chi 2$ test. The comparison of measurement data that did not conform to a normal distribution was expressed by a nonparametric test and is shown as the median (25th percentile, 75th percentile). Taking $\alpha=0.05$ as the test level, $P<0.05$ indicates a statistically significant difference.

Results

As shown in the Consort flow chart (Figure 1), 95 children were enrolled in our study, and 15 children were excluded because of withdrawal of consent, loss of follow-up, discontinued intervention or extra medication. Thus, 80 participants completed the study and were included in the final data analysis. There were no statistically significant differences between the groups in terms of age, gender, height, weight, duration of surgery and anesthesia or the type of surgery (Table 1).

Compared with the baseline, the mYPAS score of group V was found to be significantly changed at T1 ($P<0.001$). In group C, the increase in mYPAS scores showed statistically significant differences at T1, T2 and T6 ($P=0.002$, $P<0.001$ and $P<0.001$) (Figure 2). The mYPAS scores at T0 exhibiting baseline anxiety were not statistically different between the groups ($P = 0.583$) before the intervention. After the intervention,

the mYPAS scores were different between the groups at T1 (P < 0.001), T2 (P < 0.001) and T6 (P=0.001). Meanwhile, both the peak mYPAS scores and the incidence of anxiety (mYPAS score>40) showed significant differences between the two groups (P<0.001; P=0.013) (Table 2). The individual cartoon video not only reduced the level of anxiety but also shortened the duration of anxiety.

The incidence of ED (PAED≥10) in group V was significantly lower than that in group C at T3 and T4 (55% vs. 77.5%, P=0.033; 32.5% vs. 55%, P=0.043). The peak of PAED in group C was significantly higher than that in group V. Additionally, the overall incidence of severe ED (PAED≥15) showed a significant difference between group C and group V (15% vs. 35%, P=0.039), while the incidence of ED showed no significant difference (60% vs. 80%, P=0.051) (Table 3). The individual cartoon video may reduce the severity of ED and the overall incidence of severe ED.

The FLACC scores were not different between the two groups at T3, T4, T5 and T6. Similarly, the ICC and the incidence of adverse events were not found to be different (Table 4).

Discussion

In the present study, we found that individual cartoon videos can significantly alleviate perioperative anxiety and reduce the incidence of ED in pediatric patients undergoing adenoidectomy and adenotonsillectomy.

Up to 65% of all children undergoing anesthesia and surgery develop intense anxiety and fear in the preoperative holding area and during the induction of anesthesia. This anxiety can be attributed to parental separation and uncertainty about the procedure. Many studies[14] have confirmed that preoperative anxiety in young children undergoing surgery is associated with a more painful postoperative recovery and a higher incidence of sleep and other problems. A number of pharmacological and nonpharmacological measures are frequently used to prevent or alleviate anxiety in pediatrics. Although pharmacologic intervention with a sedative (i.e., midazolam) to alleviate children's anxiety is regarded as an effective method, it has been associated with delays in hospital discharge and maladaptive behavioral changes. Additionally, the difficulty in administrating premedication to children due to their reluctance or refusal is still a problem that cannot be ignored. Manyande A[15] showed that the presence of parents during induction of general anesthesia does not diminish their child's anxiety and that playing videos of the child's choice during induction is a potentially promising nonpharmacological intervention.

Most preschool children are very fond of watching cartoon videos. Gamze Inan[7] demonstrated 3 different distraction techniques on the pain and anxiety levels of children during venipuncture, in which there are only several popular fixed options, whether in cartoon movies or video games. Jeongwoo Lee[16] similarly preselected 10 movies, including 4 action movies, 4 comics, 1 science fiction and Cinderella, in his study about the effect of cartoon distraction on pediatric surgical patients. In our study, we did not limit the number and types of cartoon videos. We determined the patients' favorite cartoon video one day before the operation and downloaded it in advance. A favorite cartoon can immerse children in videos and distract their attention from the unfamiliar environment and the absence of their parents. Meanwhile, many popular cartoons are freely available with public access. Therefore, the intervention of watching individual cartoons to reduce anxiety can be used without increasing health care costs. In this way, the intervention for anxiety will be

targeted, and the effect will be maximized.

Katherine A[17] showed that the children in the group with video distraction displayed significantly less anxiety at anesthetic induction and had a smaller increase in anxiety from the holding area to induction than those in the standard care group. Patel[18] et al. also demonstrated that animated cartoon distraction produced a significant reduction in anxiety in children aged 4 to 12 years compared with the intervention of oral premedication or parental presence. These findings are consistent with our findings. We noticed that many studies focused only on preoperative anxiety and ignored the postoperative status of the patient's anxiety. After surgery, pediatric patients often cry and scream because they long for their parents' company, which is also seen as a form of anxiety. In our study, we found that the pediatric patients in the group without cartoon video distraction displayed more anxiety when they departed from the PACU than the patients in the cartoon video group. As a result, the individual cartoon videos play a key role in alleviating anxiety in the whole perioperative period.

Kain[19] pointed out an important correlation between emergence delirium and preoperative anxiety in children: for every 10-point increase in the mYPAS, the risk of delirium increases by 10%. A previous study[20] suggested that preoperative anxiety was one of the risk factors for ED. Thus, interventions aimed at alleviating preoperative anxiety are of great significance for preventing ED. In this study, the individual cartoon video is an easy and effective modality to alleviate anxiety and prevent ED. The outcome of this study showed that the overall incidence of ED in the individual cartoon video group was 20% lower than that in the control group. Specifically, the incidence of ED in the two groups showed a large difference at the time of extracting the tracheal tube and arriving at the PACU. However, the differences between the two groups at 30 min after arriving in the PACU and departing from the PACU were not statistically significant. A possible explanation for this might be that during the period when the patient is not fully awake, there is a high incidence of emergence agitation. Because the patient is not fully conscious, the sound or scene of their favorite cartoon video makes it easier for them to calm them down.

There were no significant differences in the incidence of adverse events between the two groups. However, previous studies[21] have found that ED increases the risk of these adverse events. The possible reason is that our study may be limited by the sample size. We calculated the sample size with the incidence of ED and anxiety, and a larger sample size is required for determining differences in adverse events.

Conclusion

We concluded that the individual cartoon video could significantly alleviate perioperative anxiety and reduce the incidence of emergence delirium in pediatric patients.

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Assistance with the study
none.

Author contributions
Xinyu Tang and Muchun Zhang contributed equally to this paper.
All authors contributed to the study conception and design. Material preparation and data collection were performed by Xinchen Tao, Yamei Li, Yi Wang and Xin Wang. Data analysis was conducted by Xinyu Tang and Muchun Zhang. The first draft of the manuscript was written by Xinyu Tang and Muchun Zhang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing interests statement
All authors declare that they have no competing interests.

Ethics Statement
This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). The study was performed in accordance with the Helsinki Declaration of 1964, and its later amendments. Written consent was obtained from parents (or guardians).

Data availability statement
The data to support the results of this study is available from the corresponding author on reasonable request.

Prior presentation
none

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Table 1. Demographic and surgical characteristics of the patients

	Individual cartoon video (n = 40)	Control (n = 40)	P value
Age (years)	5.75 ± 1.21	5.68 ± 1.58	0.812
Gender（male）[n (%)]	17 (42.5)	23 (57.5)	0.180
Height (cm)	114.43 ± 9.24	108.10 ± 11.92	0.319
Weight (kg)	21.47 ± 6.18	21.63 ± 5.26	0.271
Surgery length（min）	34.45 ± 12.07	34.63 ± 12.20	0.596
Anesthesia length (min)	47.35 ± 15.16	46.23 ± 14.09	0.691
Surgery [n (%)]			0.875
Adenoidectomy	15 (37.5)	17 (42.5)	
Tonsillectomy	10 (25)	10 (25)	
Adenoidectomy+ Tonsillectomy	15 (37.5)	13 (32.5)	

Data are presented as frequency (percentage) or mean ± SD (Standard Deviation).

Table 2. Perioperative pediatric anxiety between the two groups

	Individual cartoon video (n = 40)	Control (n = 40)	P value
mYPAS			
T0	44.60 [36.36~50.00]	42.09 [33.36~50.00]	0.583
T1	34.32 [32.15~38.89]	46.76 [40.04~62.94]	0.000†
T2	38.89 [33.33~44.27]	59.58 [48.44~80.00]	0.000†
T6	39.86 [33.33~59.73]	56.93 [45.85~78.81]	0.001†
Peak_mYPAS	51.00 [41.67~60.89]	64.14 [53.57~85.47]	0.000†
Anxiety [n (%)]	32 (80)	39 (97.5)	0.013†

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

†P < 0.05 versus the control group

mYPAS, Modified Yale Preoperative Anxiety Scale

T0, preoperative holding area

T1, entry to the operating room

T2, induction of anesthesia

T6, leaving the PACU

Peak_mYPAS refers to the highest score of mYPAS in the four time points of T0, T1, T2 and T6.

mYPAS score>40 is considered as the occurrence of anxiety .

Table 3. Emergence delirium between the two groups

	Individual cartoon video (n = 40)	Control (n = 40)	P value
PAED			
T3 [n (%)]	22 (55)	31 (77.5)	0.033†
T4 [n (%)]	13 (32.5)	22 (55)	0.043†
T5 [n (%)]	9 (22.5)	10 (25)	0.793
T6 [n (%)]	6 (15)	5 (12.5)	0.745
Peak_PAED	12.00 [9.00~13.00]	13.50 [10.00~15.00]	0.016†
ED [n (%)]	24 (60)	32 (80)	0.051
Severe ED [n (%)]	6 (15)	14 (35)	0.039†

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

†P < 0.05 versus the control group

PAED, the Pediatric Anesthesia Emergence Delirium scale

T3, immediately after extubation

T4, arriving in the PACU

T5, 30 min after arriving in the PACU

T6, leaving the PACU

Peak_PAED refers to the highest score of PAED in the four time points of T3, T4, T5 and T6.

PAED score≥10 is considered as the occurrence of ED.

PAED score≥15 is considered as the occurrence of severe ED

Table 4. Secondary outcomes of the patients

	Individual cartoon video (n = 40)	Control (n = 40)	P value
FLACC			
T3	3.00 [1.25~4.75]	3.50 [2.00~5.00]	0.599
T4	3.00 [1.00~5.00]	3.50 [2.00~5.75]	0.061
T5	2.50 [1.00~4.00]	3.00 [2.00~5.00]	0.058
T6	2.00 [1.00~3.75]	3.00 [1.00~4.00]	0.300
ICC	2.00 [0.00~4.00]	3.00 [1.25~4.00]	0.110
Adverse events [n (%)]	3 (7.5)	4 (10)	0.692

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

FLACC, Face, Legs, Activity, Consolability, Cry scale

T3, immediately after extubation

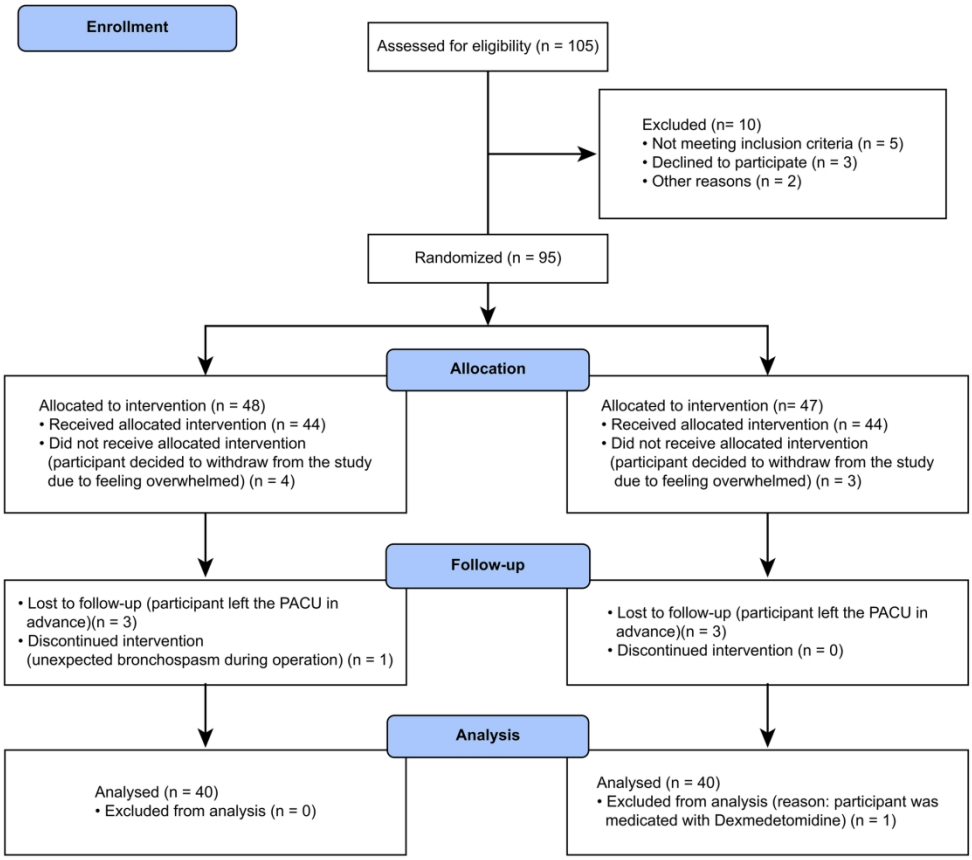
T4, arriving in the PACU

T5, 30 min after arriving in the PACU

T6, leaving the PACU

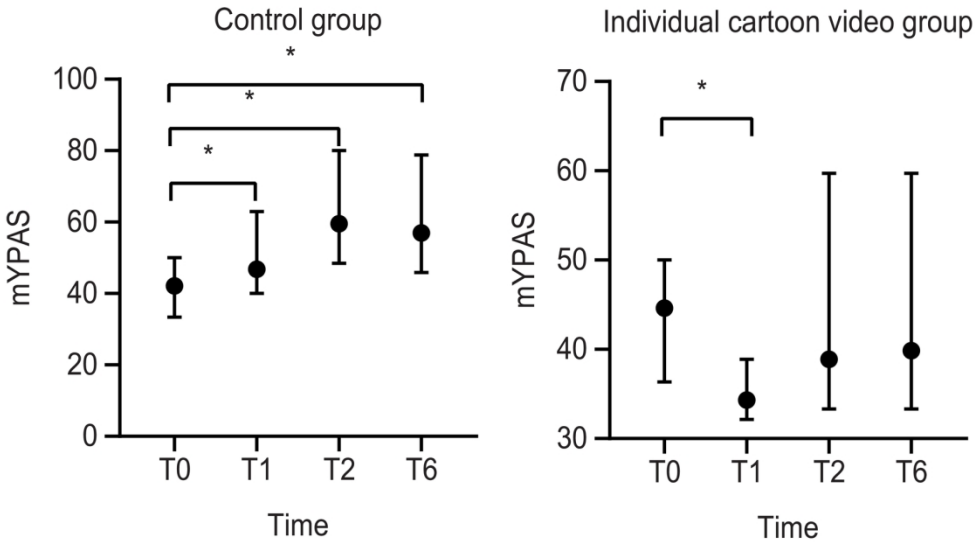
ICC, induction compliance checklist

Adverse events refer to severe hypoxemia, bronchospasm, postoperative bleeding, etc.



CONSORT flow diagram of the study.

179x157mm (300 x 300 DPI)



mYPAS score differences at T1, T2 and T6 compared with T0 in control group and individual cartoon group.
*P＜0.01 versus T0
mYPAS, Modified Yale Preoperative Anxiety Scale
T0, preoperative holding area
T1, entry to the operating room
T2, induction of anesthesia
T6, leaving the PACU

79x46mm (600 x 600 DPI)

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Individual Cartoon Video for Alleviating Perioperative Anxiety and Reducing Emergence Delirium in Children: A Prospective Randomized Trial

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Keywords:	Anesthesia, Adolescent Health

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Title page

Individual Cartoon Video for Alleviating Perioperative Anxiety and Reducing Emergence Delirium in Children: A Prospective Randomized Trial

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Abstract

BACKGROUND: Perioperative anxiety and emergence delirium in young children may cause a series of adverse events, which are worth investigating. Pharmacological treatments of anxiety and delirium remain uncertain, while nonpharmacological treatments lack personalization and pertinence.

AIMS: The aim of study was to determine whether an individual cartoon video can alleviate perioperative anxiety and reduce emergence delirium in young children undergoing adenoidectomy and tonsillectomy.

METHODS: Children between 3 and 7 years old undergoing adenoidectomy and tonsillectomy were randomly assigned to an individual cartoon video group (group V) or a control group (group C). In group V, an individual cartoon video of the child' s own choice was played throughout the whole waiting, anesthesia induction and recovery periods. The children in group C were contacted through verbal conversation. The primary outcomes were anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS) and emergence delirium assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The secondary outcomes included cooperation during induction, postoperative pain and adverse events.

RESULTS: The incidence of anxiety were comparable in group V and group C at the holding area (T0)(26% vs. 22%, P=0.323), but the incidence of anxiety of group V were significantly lower than those of group C at the time of entering the operating room (T1), during the induction of anesthesia (T2) and leaving the PACU (T6) (P<0.001, P<0.001, P < 0.001) after intervention. The peak PAED score in group V was significantly lower than that in group C (12.00 [9.00~13.00] vs. 13.50 [10.00~15.00], P=0.016). We found no significant differences in cooperation during induction, postoperative pain or the incidence of adverse events between the groups (2.00 [0.00~4.00] vs. 3.00 [1.25~4.00], P=0.110; F=0.059, Pgroup=0.808; 3 (7.5%) vs. 4 (10), P=0.692).

CONCLUSIONS: The individual cartoon video is an effective method of reducing perioperative anxiety and alleviating emergence delirium in children.

Ethics Approval Statement

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1))

Clinical Trial Registration Identifier

ChiCTR2200062300 (https://www.chictr.org.cn/index.aspx)

KEY WORDS： individual cartoon video；anxiety；emergence delirium；pediatrics;

What is already known about the topic?

Anxiety and emergence delirium are commonly observed in young children and cause many adverse effects.

Pharmacological treatments of anxiety and emergence delirium remain uncertain, while nonpharmacological treatments lack personalization and pertinence.

What new information this study adds?

Using a child' s favorite cartoon video can reduce the incidence of perioperative anxiety.

Using a child' s favorite cartoon video may alleviate emergence delirium.

How this study might affect the practice?

The patients' favorite cartoon video can be played as the intervention for anxiety and emergence delirium, which will be targeted, easy-accessed and the effect will be maximized.

Introduction

Emergence delirium (ED) is described as a complex of perceptual disturbances and psychomotor agitation that most commonly observed in young children in the early postanesthetic period following a sevoflurane-based anesthetic[1]. While, anxiety is a common abnormal psychological state before pediatric anesthesia and surgery. It has been reported that up to 65% of children in the holding area and during the induction of anesthesia experience intense anxiety about anesthesia and surgery[2]. Severe anxiety easily causes uncooperative behavior, severe pain, emergence delirium, and higher doses of sedation or preoperative analgesia[3-5]. Therefore, alleviating anxiety and reducing the incidence of ED in children are of great significance for ensuring perioperative safety and improving surgical prognosis.

Tailored treatment for perioperative anxiety of a pediatric patient can use either pharmacological or non-pharmacological methods, often in tandem. The use of anxiolytic premedication in particular is valuable for certain groups[6], but the efficacy of these drugs is not clear, and the optimal dosage is unknown. In addition, due to the immaturity of children's physical and psychological development, pharmacological treatment has side effects and potential risks, and the compliance of young children in taking medication is low. Compared with pharmacological therapy, non-pharmacological interventions are more comfortable, safer and free of drug side effects[7].

As a whole non-pharmacological modalities comprise education approaches, behavioral techniques, parental presence at induction of anesthesia (PPIA), and complementary and alternative medicine (CAM) techniques, with each category including a range of effective strategies for reducing anxiety[7]. Research has increasingly focused on exploring the effects of technology devices, especially based on audiovisual interventions[8]. These technology devices (eg, smartphones[9, 10], video glasses[11], streaming videoplayers[12], portable computers[13, 14], iPads[15], and video games[16]) have been widely used as a vehicle for streaming media content(eg, video games, streaming video clips, apps[17], virtual reality, and cartoons) to reduce perioperative anxiety in children through distraction.

Cohen et al. used cartoons as an effective distraction tool during surgical procedures in children and in another study demonstrated that playing age-appropriate videos before medical procedures was

a more effective distractor than was an interactive toy[18, 19]. Compared with premedication or parental presence only, a handheld video game with parental presence was found to be more effective for reducing anxiety in children aged 4 to 12 years[16]. A study also demonstrates that pediatric patients who used VR were found to have significantly lower anxiety at the time of induction of anesthesia compared to patients who did not use VR[20]. However, we found that the choices of the videos[21], handheld video games[16] or VR[20] in previous studies seemed to be impersonalized and limited. Most studies used the same media content as interventions, regardless of the gender and age of patients[20, 22]. Even if the selection is based on age and gender, it is possible that the children cannot find his favorite cartoon video in the options of his age due to individual differences. Meanwhile, it has been proved that the causes of emergence delirium are related to preoperative anxiety and that reducing preoperative anxiety can reduce the incidence of postoperative delirium[1, 23]. Therefore, some studies have focused only on how to reduce preoperative anxiety, while few have continued to pay attention to the anxiety of children who are awakening in the PACU[1].

Therefore, this study was performed to determine whether individual cartoon videos are capable of alleviating perioperative anxiety and reducing emergence delirium in young children undergoing adenoidectomy and tonsillectomy.

Methods

Ethics

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). Written consent was obtained from parents (or guardians). This single-center, randomized clinical trial was conducted from August to September 2022 in accordance with the principles of the Helsinki Declaration.

Participants

Ninety-five patients aged between 3 and 7 years with an American Society of Anesthesiologists physical status I-II and who were scheduled for their first elective adenoidectomy or tonsillectomy under general anesthesia were enrolled. Children having emergency surgery and those with previous anesthetic experience, developmental delays, intellectual disability, sedative medication or chronic illnesses were excluded from the study.

Patient and Public Involvement

Parents or the public were not directly involved in the design, conduct or plans for the dissemination of our research.

Procedures

The day before surgery, the eligible patients were visited by a trained anesthesiologist, and their general information was recorded. Most importantly, through conversations with children, their favorite cartoon videos even specific to favorite clips were all recorded. There were no limits to the scope of cartoons, which were freely chosen according to children's preferences. On the day of

surgery, all of the patients were brought to the holding area 30 min before surgery and treated according to the group assignment. The enrolled children were randomized into two groups using a computer-generated randomization program: group V (distraction by watching an individual cartoon video) and group C (control). The patients in group V began to watch a favorite cartoon video on iPad throughout the whole waiting and anesthesia induction process. Patients in group C were contacted by the medical staff through verbal conversation to relieve their anxiety.

The surgical interventions and the administration of anesthesia were always performed by the same professionals (two surgeons and an anesthesiologist), and standard anesthetic regimens and techniques were used for all patients. After the application of standard monitoring, including blood pressure, electrocardiography, blood oxygen saturation, and the bispectral index, inhalation anesthesia induction was performed at tidal volume, with incrementing sevoflurane up to 8% with a 50% mixture of air and oxygen (6 L/min). At the same time, the induction compliance checklist (ICC) score was recorded by a trained nurse. Peripheral IV access was obtained, and an appropriately sized laryngeal tube was inserted after a suitable anesthetic depth was obtained by the injection of propofol (2 mg/kg), sufentanil (0.2 μg/kg) and cisatracurium (0.1 mg/kg). Then, atropine (0.02 mg/kg) and dexamethasone (0.1 mg/kg) were administered, and anesthesia was maintained with remifentanil 0.2-0.3 μg/kg/min and sevoflurane 3%-5% with a BIS target range of 40-60. At the end of surgery, the children were extubated after awakening with adequate spontaneous ventilation and were transferred to the postanesthetic care unit (PACU) for observation. In group V, the individual cartoon video was continuously played in the early recovery stage until the children left the PACU and were reunited with their parents.

Measures

Every assessment was completed by the same trained anesthesiologist who is blinded to the group allocation. The primary outcomes were perioperative pediatric anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS) and ED assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The mYPAS is a validated perioperative pediatric anxiety instrument with 22 items in 5 categories (activity, emotional expressivity, state of arousal, vocalization, and use of parents)[24]. In terms of activity, this domain measures the child's level of activity or restlessness, for example, whether the child is fidgeting in their seat or moving around the room. The domain of emotional expressivity estimates the child's emotional state and expression, for example, the child is crying, worried or happy. In terms of state of arousal, this domain measures the child's physiological arousal, such as vigilance, sucking on thumb or panicked whimpering. The domain of vocalization investigates whether the child is reading, moaning, screaming, etc. And in terms of use of parents, it measures the child's reliance on their parents for comfort and support. Scores range from 23.33 to 100, with higher scores indicating higher levels of anxiety[25]. The mYPAS was administered at 4 time points: in the preoperative holding area (baseline, or T0), upon entering the operating room (T1), during the induction of anesthesia (T2) and upon leaving the PACU (T6). Behavior on emergence was measured using the pediatric anesthesia emergence delirium (PAED) scale[26]. A specially trained anesthesiologist assessed the PAED scale at 4 time points: immediately after extubation (T3), on arriving in the PACU (T4), 30 min after arriving in the PACU (T5) and on leaving the PACU (T6). ED was defined as PAED scores ≥10, and PAED scores≥15 is considered

as the occurrence of severe ED[26-30]. The PAED scale was also used to measure the intensity of ED, where 0 represents no ED and 20 is the maximum intensity of ED. The induction compliance checklist (ICC) was used to assess the cooperation of the children during the induction of anesthesia (T2). A validated simplified 3-point scoring system for ICC [perfect (ICC = 0), moderate (ICC = 1–3), and poor (ICC ≥ 4)] was used in our trial[31]. The FLACC assessment tool was also administered to measure postoperative pain at the same time as PAED. The FLACC scale scores the pain intensity by rating five behaviors (face, legs, activity, consolability and cry) to derive a score out of 10.[32] For the patients suffering from ED, the first measure was to comfort the patients with words. When this failed, the patients were treated with propofol (10-20 mg IV). If a child exhibited signs of pain with a FLACC scale **>** 4, sufentanil (0.05 μg/kg IV) was administered as rescue medication.

Statistical analysis

For the sample size calculation, we used a proportion of ED and anxiety of 50%, as reported in previously published studies[2, 33]. Therefore, 40 subjects per group would have a significance level of 5% and a power of 80% in detecting a 30% reduction in ED incidence between the groups. While anticipating a 15% dropout rate, we estimated that 46 patients were needed in each group.

SPSS 26.0 statistical software was used to statistically process and analyze the data. The measurement data conforming to the normal distribution were expressed as the mean ± standard deviation, and the comparison between the groups was performed by two independent samples t test. Enumeration data were expressed by the number of patients (percentage) [n(%)], and the comparison was made by Chi-Squared Test. The comparison of measurement data that did not conform to a normal distribution was expressed by a nonparametric test and is shown as the median (25th percentile, 75th percentile).

The changes of anxiety and emergence delirium over time between two groups were evaluated by generalized linear mixed models(GLMM) with logistic link followed by pairwise comparisons with Bonferroni correction. Linear mixed model(LMM) was used to evaluate the change of pain for comparison of FLACC. Both GLMM with logistic link and LMM were adjusted for age, gender, surgery type and length of surgery and anesthesia. Taking α=0.05 as the test level, P<0.05 indicates a statistically significant difference.

Results

As shown in the Consort flow chart (Figure 1), 95 children were enrolled in our study, and 15 children were excluded because of withdrawal of consent, loss of follow-up, discontinued intervention or extra medication. Thus, 80 participants completed the study and were included in the final data analysis. There were no statistically significant differences between the groups in terms of age, gender, height, weight, duration of surgery and anesthesia or the type of surgery (Table 1).

The incidence of anxiety was significantly different over time among children (F=3.212, P=0.023). There is also a significant difference in the incidence of anxiety between group V and group C (F=34.943, P **<** 0.001)(Figure 2, Table 2). Moreover, the interaction effect between time and group

was statistically significant (F=8.126, P < 0.001)(Table 2). The incidence of anxiety at T0 exhibiting baseline anxiety was not statistically different between the groups (P = 0.323). After the intervention, the incidence of anxiety of group V is significantly lower than that of group C at T1 (P < 0.001), T2 (P < 0.001) and T6 (P < 0.001) (Figure 2) . Meanwhile, the peak mYPAS scores showed significant difference between the two groups (P<0.001) (Table 2).

The incidence of ED was significantly different over time among children (F=15.688, P < 0.001). However, the incidence of ED between the groups and the interaction effect between time and group were not statistically different (F=2.169, P=0.142; F=1.220, P=0.302). Additionally, the peak of PAED in group V was significantly lower than that in group C (P=0.016) (Table 3).

The FLACC score was significantly decreased over time among children (F=3.870, P=0.010). However, the FLACC scores between the groups and the interaction effect between time and group were not statistically different (F=0.059, P=0.808; F=1.381, P=0.249). Similarly, the ICC and the incidence of adverse events were not found to be significantly different (P=0.110, P=0.692) (Table 4).

Discussion

In the present study, we found that individual cartoon videos can significantly reduce the incidence of perioperative anxiety and alleviate ED in pediatric patients undergoing adenoidectomy and adenotonsillectomy.

As demonstrated in Figure2, the incidence of anxiety at T0 was not significantly different between the two groups. The individual cartoon video helped the children in group V reduce anxiety at T1. While the incidence of anxiety at T1 in group C was higher than that at T0. This indicates that simply watching the individual cartoon video at holding area may have been sufficient to reduce anxiety during entry into the operation room. Without the impact of intervention measure, the children in group C showed the increasing levels of anxiety. While children who watched the individual cartoon video had lower levels of anxiety at T1, T2 and T6 compared to that at T0. These findings are sufficient to demonstrate a strong benefit of individual cartoon video by reducing the anxiety of pediatric patients during the whole perioperative period. Kain[4] pointed out an important correlation between emergence delirium and preoperative anxiety in children: for every 10-point increase in the mYPAS, the risk of delirium increases by 10%. A previous study[34] suggested that preoperative anxiety was one of the risk factors for ED. Thus, interventions aimed at alleviating preoperative anxiety are of great significance for preventing ED. However, few studies evaluated the effect of non-pharmacological approaches especially the technology devices in reducing the emergence delirium. In our study, analyzing the emergence delirium in the generalized linear mixed models (GLMM) with logistic link, we did not find the significant difference in the groups and the interaction effect between time and group. When comparing the peak PAED scores between the groups, we found that the degree of ED in group V is significantly lower than that in group C. These results show that the individual cartoon video can only alleviate the severity of ED and fails to

reduce the incidence of ED. Our study may not have been powered to fully demonstrate the association of other factors with anxiety and emergence delirium, such as age, gender, surgery type and length of surgery and anesthesia. In the study, these factors did not differ between the two groups, had no impact in the multivariable analysis, and thus did not impact our conclusions. There were no significant differences in the incidence of adverse events between the two groups. However, previous studies[35] have found that ED increases the risk of these adverse events. The possible reason is that our study may be limited by the sample size. We calculated the sample size with the incidence of ED and anxiety, and a larger sample size is required for determining differences in adverse events.

Most young children are very fond of watching cartoon videos. A favorite cartoon can immerse children in videos and distract their attention from the unfamiliar environment and the absence of their parents so that children will not cry because of fear and anxiety. Meanwhile, many popular cartoons are freely available with public access. Therefore, the intervention of watching individual cartoons to reduce anxiety can be used without increasing health care costs. Gamze Inan[36] demonstrated 3 different distraction techniques on the pain and anxiety levels of children during venipuncture, in which there are only several popular fixed options, whether in cartoon movies or video games. Jeongwoo Lee[22] similarly preselected 10 movies, including 4 action movies, 4 comics, 1 science fiction and Cinderella, in his study about the effect of cartoon distraction on pediatric surgical patients. In our study, we did not limit the number and types of cartoon videos. We determined the patients' favorite cartoon video one day before the operation and downloaded it in advance. In this way, the intervention for anxiety will be targeted, and the effect will be maximized.

Katherine A[12] showed that the children in the group with video distraction displayed significantly less anxiety at anesthetic induction and had a smaller increase in anxiety from the holding area to induction than those in the standard care group. Patel[16] et al. also demonstrated that animated cartoon distraction produced a significant reduction in anxiety in children aged 4 to 12 years compared with the intervention of oral premedication or parental presence. These findings are consistent with our findings. We noticed that many studies focused only on preoperative anxiety and ignored the postoperative status of the patient's anxiety. In daily work, we observed that some pediatric patients often cry and scream after surgery. We speculate that they may long for the company of their parents, which could also be a form of anxiety. In our study, we found that the pediatric patients in the control group displayed more anxiety when they departed from the PACU than the patients who watched the individual cartoon videos. As a result, the individual cartoon videos play a key role in alleviating anxiety in the whole perioperative period.

Video display for pediatric patients has been an emerging audiovisual distraction modality to reduce anxiety. Initial studies in audiovisual distraction during induction of anesthesia in pediatric patients used video games, apps and streaming video clips to demonstrate reductions in mYPAS scores[12, 16, 17]. We innovatively chose the individual cartoon video as the intervention throughout the whole perioperative period to evaluate the anxiety and ED. Thus, the purpose and findings of this study complement existing literature examining perioperative psychological and mental state of children and offer a fresh approach to relieve perioperative anxiety and ED in pediatric patients.

In terms of the strengths of this study, first of all, the individual cartoon video is an easy and effective modality which can capture children's attention to the maximum extent and is freely available with public access. Secondly, the established outcome scales we used are validated and behavior based to reduce observer bias. Thirdly, we included a time point after surgery to evaluate the anxiety in children and ultimately confirmed that the individual cartoon video can reduce anxiety throughout the whole perioperative period.

Several limitations related to this study should also be discussed. One limitation is that the outcomes were limited to the immediate period. Though it has been proved that the negative psychological impact of perioperative anxiety can stretch beyond the perioperative period and includes maladaptive postoperative behaviors, such as separation anxiety, nightmares and eating disorders[37-40], it remains unclear whether interventions aimed at reducing preoperative anxiety would lead to a decrease in such behaviors. Besides, the sample size of study is relatively limited. We found no significant difference of adverse events between the two groups. The most likely reason is that we calculated the sample size based on the incidence of ED and anxiety. Thus, the number of children recruited may have been insufficient to detect the effects of the individual cartoon videos on postoperative adverse events. Thirdly, though the trained investigator was blinded to the group allocation before assessment, the blinding was impossible at some time points because cartoon video watching were visible to the investigator. As a result, observer bias may have influenced assessments of anxiety, emergence delirium, pain and compliance at induction of anesthesia.

On the basis of our findings, future directions for further studies include longer postoperative follow-up, larger sample size and more application fileds, including pediatric cardiovascular and cerebrovascular intervention therapies, radiological examinations and endoscopic examinations and treatments outside the operation room.

Conclusion

We concluded that the individual cartoon video was demonstrated to be an easy, effective and noninvasive modality for perioperative anxiety and emergence delirium in pediatric patients.

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Assistance with the study

none.

Author contributions

Xinyu Tang and Muchun Zhang contributed equally to this paper.

All authors contributed to the study conception and design. Material preparation and data

collection were performed by Xinchen Tao, Yamei Li, Yi Wang and Xin Wang. Data analysis was conducted by Xinyu Tang and Muchun Zhang. The first draft of the manuscript was written by Xinyu Tang and Muchun Zhang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing interests statement

All authors declare that they have no competing interests.

Ethics Statement

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). The study was performed in accordance with the Helsinki Declaration of 1964, and its later amendments. Written consent was obtained from parents (or guardians).

Data availability statement

The data to support the results of this study is available from the corresponding author on reasonable request.

Prior presentation

none

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		Individual cartoon video (n = 40)	Control (n = 40)	P value
Age (years)[a]		5.75 ± 1.21	5.68 ± 1.58	0.812
Gender (male) [n (%)][b]		17 (42.5)	23 (57.5)	0.18
Height (cm)[a]		114.43 ± 9.24	108.10 ± 11.92	0.319
Weight (kg)[a]		21.47 ± 6.18	21.63 ± 5.26	0.271
Surgery length (min) [a]		34.45 ± 12.07	34.63 ± 12.20	0.596
Anesthesia length (min)[a]		47.35 ± 15.16	46.23 ± 14.09	0.691
Surgery [n (%)][b]				0.875
	Adenoidectomy	15 (37.5)	17 (42.5)	
	Tonsillectomy	10 (25)	10 (25)	

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	Adenoidectomy+ Tonsillectomy	15 (37.5)	13 (32.5)	

Table 1. Demographic and surgical characteristics of the pediatric patients between individual cartoon video group and control group

Data are presented as frequency (percentage) or mean ± SD (Standard Deviation).

[a]two independent samples t test

[b]Chi-Squared Test

Table2. Anxiety occurrence and levels in pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n=40)	Control (n=40)	P value
Anxiety[a]				< 0.001*
	T0 [n(%)]	26(65)	22(55)	
	T1 [n(%)]	8(20)	32(80)	
	T2 [n(%)]	16(40)	36(90)	
	T6 [n(%)]	21(52.5)	35(87.5)	
Peak_mYPAS[b]		51.00 [41.67~60.89]	64.14 [53.57~85.47]	< 0.001†

*P_{time}=0.023 *P_{group} < 0.001 *$P_{interaction}$ < 0.001

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Generalized Linear Mixed Model(GLMM) with logistic link was adjusted for age, gender, surgery type and length of surgery and anesthesia.
[b]Mann–Whitney U-test
mYPAS, Modified Yale Preoperative Anxiety Scale
T0, preoperative holding area
T1, entry to the operating room
T2, induction of anesthesia
T6, leaving the PACU

mYPAS > 40 is considered as the occurrence of anxiety.

Peak_mYPAS refers to the highest score of mYPAS in the four time points of T0, T1, T2 and T6.

*P < 0.05 is significant in GLMM with logistic link.

†P < 0.05 versus the control group.

Table3. Emergence delirium occurrence and levels in pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n=40)	Control (n=40)	P value
ED[a]				0.302
	T3 [n(%)]	22(55)	31(77.5)	
	T4 [n(%)]	13(32.5)	22(55)	
	T5 [n(%)]	9(22.5)	10(25)	
	T6 [n(%)]	6(15)	5(12.5)	
Peak_PAED[b]		12.00 [9.00~13.00]	13.50 [10.00~15.00]	0.016†

*P_{time} < 0.001 P_{group}=0.142 $P_{interaction}$=0.302

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Generalized Linear Mixed Model(GLMM) with logistic link was adjusted for age, gender, surgery type and length of surgery and anesthesia.

[b]Mann–Whitney U-test

PAED, the Pediatric Anesthesia Emergence Delirium scale

T3, immediately after extubation

T4, arriving in the PACU

T5, 30 min after arriving in the PACU

T6, leaving the PACU

Peak_PAED refers to the highest score of PAED in the four time points of T3, T4, T5 and T6.

PAED≥10 is considered as the occurrence of emergence delirium.

*P < 0.05 is significant in GLMM with logistic link.

†P < 0.05 versus the control group.

Table 4. Secondary outcomes of the pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n = 40)	Control (n = 40)	P value
FLACC[a]				0.249
	T3	3.00 [1.25~4.75]	3.50 [2.00~5.00]	
	T4	3.00 [1.00~5.00]	3.50 [2.00~5.75]	
	T5	2.50 [1.00~4.00]	3.00 [2.00~5.00]	
	T6	2.00 [1.00~3.75]	3.00 [1.00~4.00]	

ICC[b]		2.00 [0.00~4.00]	3.00 [1.25~4.00]	0.11
Adverse events[c] [n (%)]		3 (7.5)	4 (10)	0.692

*P_{time}=0.010 P_{group}=0.808 $P_{interaction}$=0.249

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Linear Mixed Model(LMM) was adjusted for age, gender, surgery type and length of surgery and anesthesia.

[b]Mann–Whitney U-test

[c]Chi-Squared Test

FLACC, Face, Legs, Activity, Consolability, Cry scale

T3, immediately after extubation

T4, arriving in the PACU

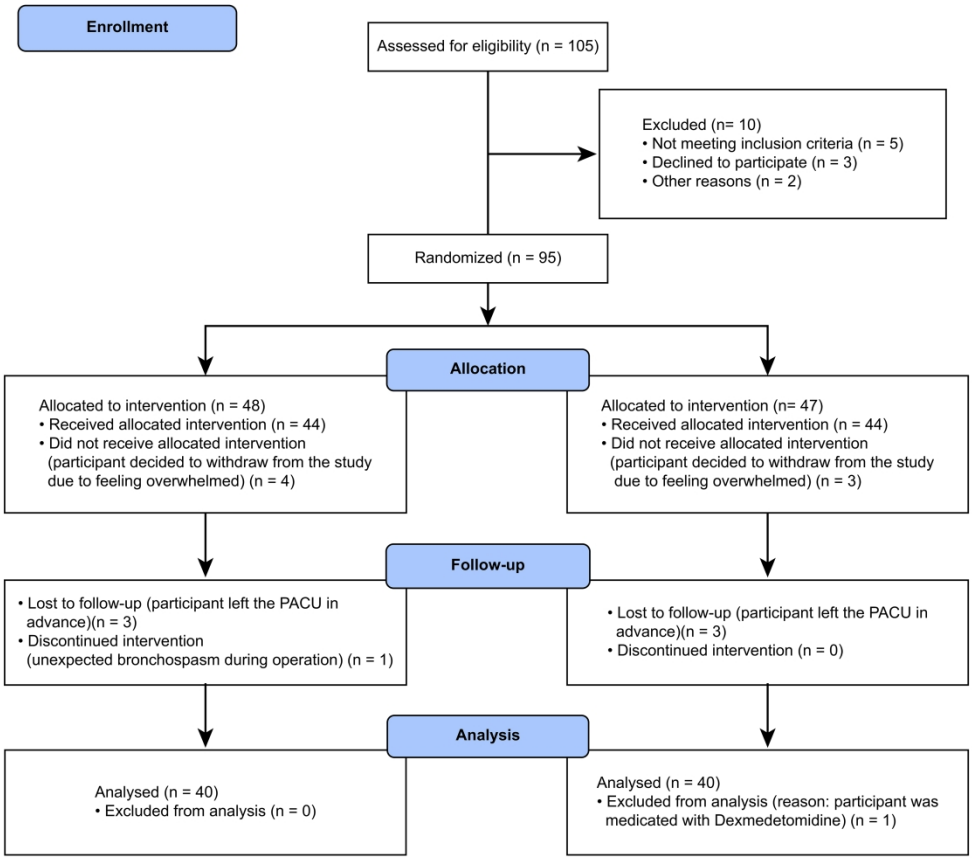
T5, 30 min after arriving in the PACU

T6, leaving the PACU

ICC, induction compliance checklist

Adverse events refer to severe hypoxemia, bronchospasm, postoperative bleeding, etc.

*P < 0.05 is significant in LMM.



CONSORT flow diagram of the study.

179x157mm (580 x 580 DPI)

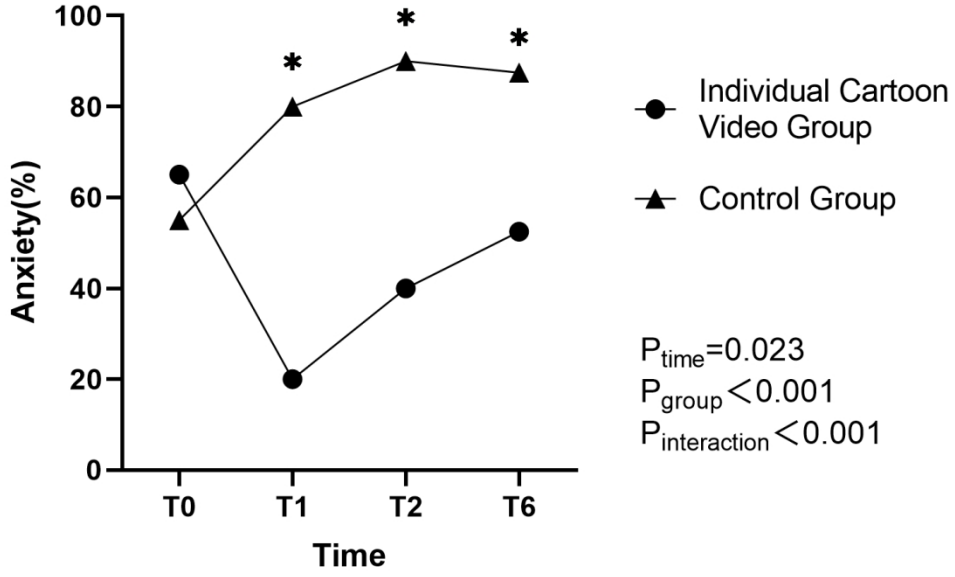


Figure2: Anxiety occurrence in pediatric patients in the perioperative period
□P＜0.001 versus the control group

132x84mm (300 x 300 DPI)

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Title page

Individual Cartoon Video for Alleviating Perioperative Anxiety and Reducing Emergence Delirium in Children: A Prospective Randomized Trial

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Abstract

BACKGROUND: Perioperative anxiety and emergence delirium in young children may cause a series of adverse events, which are worth investigating. Pharmacological treatments of anxiety and delirium remain uncertain, while nonpharmacological treatments lack personalization and pertinence.

AIMS: The aim of study was to determine whether an individual cartoon video can alleviate perioperative anxiety and reduce emergence delirium in young children undergoing adenoidectomy and tonsillectomy.

METHODS: Children between 3 and 7 years old undergoing adenoidectomy and tonsillectomy were randomly assigned to an individual cartoon video group (group V) or a control group (group C). In group V, an individual cartoon video of the child' s own choice was played throughout the whole waiting, anesthesia induction and recovery periods. The children in group C were contacted through verbal conversation. The primary outcomes were anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS) and emergence delirium assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The secondary outcomes included cooperation during induction, postoperative pain and adverse events.

RESULTS: The incidence of anxiety were comparable in group V and group C at the holding area (T0)(26% vs. 22%, P=0.323), but the incidence of anxiety of group V were significantly lower than those of group C at the time of entering the operating room (T1), during the induction of anesthesia (T2) and leaving the PACU (T6) (P<0.001, P<0.001, P < 0.001) after intervention. The peak PAED score in group V was significantly lower than that in group C (12.00 [9.00~13.00] vs. 13.50 [10.00~15.00], P=0.016). We found no significant differences in cooperation during induction, postoperative pain or the incidence of adverse events between the groups (2.00 [0.00~4.00] vs. 3.00 [1.25~4.00], P=0.110; F=0.059, Pgroup=0.808; 3 (7.5%) vs. 4 (10), P=0.692).

CONCLUSIONS: The individual cartoon video is an effective method of reducing perioperative anxiety and alleviating emergence delirium in children.

Ethics Approval Statement

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1))

Clinical Trial Registration Identifier

ChiCTR2200062300 (https://www.chictr.org.cn/index.aspx)

KEY WORDS： individual cartoon video；anxiety；emergence delirium；pediatrics;

What is already known about the topic?

Anxiety and emergence delirium are commonly observed in young children and cause many adverse effects.

The effectiveness of pharmacological treatments of anxiety and emergence delirium remains uncertain, while the effectiveness of nonpharmacological treatments lacks personalization and pertinence.

What new information this study adds?

Using a child' s favorite cartoon video can reduce the incidence of perioperative anxiety.

Using a child' s favorite cartoon video may alleviate emergence delirium.

How this study might affect the practice?

The patients' favorite cartoon video can be played as the intervention for anxiety and emergence delirium, which will be targeted, easy-accessed and the effect will be maximized.

Introduction

Emergence delirium (ED) is described as a complex of perceptual disturbances and psychomotor agitation that most commonly observed in young children in the early postanesthetic period following a sevoflurane-based anesthetic[1]. While, anxiety is common in children before anesthesia and surgery. It has been reported that up to 65% of children in the holding area and during the induction of anesthesia experience intense anxiety about anesthesia and surgery[2]. Severe anxiety easily causes uncooperative behavior, severe pain, emergence delirium, and higher doses of sedation or preoperative analgesia[3-5]. Therefore, alleviating anxiety and reducing the incidence of ED in children are of great significance for ensuring perioperative safety and improving surgical prognosis.

Tailored treatment for perioperative anxiety of a pediatric patient can use either pharmacological or non-pharmacological methods, often in tandem. The use of anxiolytic premedication in particular is valuable for certain groups[6], but the efficacy of these drugs is not clear, and the optimal dosage is unknown. In addition, due to the immaturity of children's physical and psychological development, pharmacological treatment has side effects and potential risks, and the compliance of young children in taking medication is low. Compared with pharmacological therapy, non-pharmacological interventions are more comfortable, safer and free of drug side effects[7].

As a whole non-pharmacological modalities comprise education approaches, behavioral techniques, parental presence at induction of anesthesia (PPIA), and complementary and alternative medicine (CAM) techniques, with each category including a range of effective strategies for reducing anxiety[7]. Research has increasingly focused on exploring the effects of technology devices, especially based on audiovisual interventions[8]. These technology devices (eg, smartphones[9, 10], video glasses[11], streaming videoplayers[12], portable computers[13, 14], iPads[15], and video games[16]) have been widely used as a vehicle for streaming media content(eg, video games, streaming video clips, apps[17], virtual reality, and cartoons) to reduce perioperative anxiety in children through distraction.

Cohen et al. used cartoons as an effective distraction tool during surgical procedures in children and in another study demonstrated that playing age-appropriate videos before medical procedures was

a more effective distractor than was an interactive toy[18, 19]. Compared with premedication or parental presence only, a handheld video game with parental presence was found to be more effective for reducing anxiety in children aged 4 to 12 years[16]. A study also demonstrates that pediatric patients who used Virtual Reality (VR) were found to have significantly lower anxiety at the time of induction of anesthesia compared to patients who did not use VR[20]. However, we found that the choices of the videos[21], handheld video games[16] or VR[20] in previous studies seemed to be impersonalized and limited. Most studies used the same media content as interventions, regardless of the gender and age of patients[20, 22]. Even if the selection is based on age and gender, it is possible that the children cannot find his favorite cartoon video in the options of his age due to individual differences. Meanwhile, it has been proved that one of the causes of emergence delirium was preoperative anxiety and that reducing preoperative anxiety can reduce the incidence of postoperative delirium[1, 23]. Therefore, some studies have focused only on how to reduce preoperative anxiety, while few have continued to pay attention to the anxiety of children who are awakening in the Post Anesthesia Care Unit (PACU)[1].

Therefore, this study was performed to emphatically determine whether individual cartoon videos are capable of alleviating perioperative anxiety and reducing emergence delirium in young children undergoing adenoidectomy and tonsillectomy. Simultaneously, the study also investigated the impact of individual cartoon videos on induction compliance, postoperative pain and adverse events.

Methods

Ethics

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). Written consent was obtained from parents (or guardians). This single-center, randomized clinical trial was conducted from August to September 2022 in accordance with the principles of the Helsinki Declaration.

Participants

After the introduction and invitation of the clinical trial leader, ninety-five patients aged between 3 and 7 years with an American Society of Anesthesiologists physical status I-II and who were scheduled for their first elective adenoidectomy or tonsillectomy under general anesthesia were enrolled. Children having emergency surgery and those with previous anesthetic experience, developmental delays, intellectual disability, sedative medication or chronic illnesses were excluded from the study.

Patient and Public Involvement

Parents or the public were not directly involved in the design, conduct or plans for the dissemination of our research.

Procedures

The day before surgery, the eligible patients were visited by a trained anesthesiologist, and their general information was recorded. Most importantly, through conversations with children, their favorite cartoon videos even specific to favorite clips were all recorded. There were no limits to the

scope of cartoons, which were freely chosen according to children's preferences. On the day of surgery, all of the patients were brought to the holding area 30 min before surgery and treated according to the group assignment. The enrolled children were randomized into two groups using a computer-generated randomization program: group V (distraction by watching an individual cartoon video) and group C (control). The patients in group V began to watch a favorite cartoon video on iPad throughout the whole waiting and anesthesia induction process. Patients in group C were contacted by the medical staff through verbal conversation to relieve their anxiety.

The surgical interventions and the administration of anesthesia were always performed by the same professionals (two surgeons and an anesthesiologist), and standard anesthetic regimens and techniques were used for all patients. After the application of standard monitoring, including blood pressure, electrocardiography, blood oxygen saturation, and the bispectral index, inhalation anesthesia induction was performed at tidal volume, with incrementing sevoflurane up to 8% with a 50% mixture of air and oxygen (6 L/min). At the same time, the induction compliance checklist (ICC) score was recorded by a trained nurse. Peripheral IV access was obtained, and an appropriately sized laryngeal tube was inserted after a suitable anesthetic depth was obtained by the injection of propofol (2 mg/kg), sufentanil (0.2 μg/kg) and cisatracurium (0.1 mg/kg). Then, atropine (0.02 mg/kg) and dexamethasone (0.1 mg/kg) were administered, and anesthesia was maintained with remifentanil 0.2-0.3 μg/kg/min and sevoflurane 3%-5% with a BIS target range of 40-60. At the end of surgery, the children were extubated after awakening with adequate spontaneous ventilation and were transferred to the postanesthetic care unit (PACU) for observation. In group V, the individual cartoon video was continuously played in the early recovery stage until the children left the PACU and were reunited with their parents.

Measures

Every assessment was completed by the same trained anesthesiologist who is blinded to the group allocation. The primary outcomes were perioperative pediatric anxiety measured by the Modified Yale Preoperative Anxiety Scale (mYPAS) and ED assessed by the Pediatric Anesthesia Emergence Delirium (PAED) scale. The mYPAS is a validated perioperative pediatric anxiety instrument with 22 items in 5 categories (activity, emotional expressivity, state of arousal, vocalization, and use of parents)[24]. In terms of activity, this domain measures the child's level of activity or restlessness, for example, whether the child is fidgeting in their seat or moving around the room. The domain of emotional expressivity estimates the child's emotional state and expression, for example, the child is crying, worried or happy. In terms of state of arousal, this domain measures the child's physiological arousal, such as vigilance, sucking on thumb or panicked whimpering. The domain of vocalization investigates whether the child is reading, moaning, screaming, etc. And in terms of use of parents, it measures the child's reliance on their parents for comfort and support. Scores range from 23.33 to 100, with higher scores indicating higher levels of anxiety[25]. The mYPAS was administered at 4 time points: in the preoperative holding area (baseline, or T0), upon entering the operating room (T1), during the induction of anesthesia (T2) and upon leaving the PACU (T6). Behavior on emergence was measured using the pediatric anesthesia emergence delirium (PAED) scale[26]. A specially trained anesthesiologist assessed the PAED scale at 4 time points: immediately after extubation (T3), on arriving in the PACU (T4), 30 min after arriving in the PACU (T5) and on leaving the PACU (T6). ED was defined as PAED scores ≥10, and PAED scores≥15 is considered

as the occurrence of severe ED[26-30]. The PAED scale was also used to measure the intensity of ED, where 0 represents no ED and 20 is the maximum intensity of ED. The induction compliance checklist (ICC) was used to assess the cooperation of the children during the induction of anesthesia (T2). A validated simplified 3-point scoring system for ICC [perfect (ICC = 0), moderate (ICC = 1–3), and poor (ICC ≥ 4)] was used in our trial[31]. The FLACC assessment tool was also administered to measure postoperative pain at the same time as PAED. The FLACC scale scores the pain intensity by rating five behaviors (face, legs, activity, consolability and cry) to derive a score out of 10.[32] For the patients suffering from ED, the first measure was to comfort the patients with words. When this failed, the patients were treated with propofol (10-20 mg IV). If a child exhibited signs of pain with a FLACC scale **>** 4, sufentanil (0.05 μg/kg IV) was administered as rescue medication.

Statistical analysis

For the sample size calculation, we used a proportion of ED and anxiety of 50%, as reported in previously published studies[2, 33]. Therefore, 40 subjects per group would have a significance level of 5% and a power of 80% in detecting a 30% reduction in ED incidence between the groups. While anticipating a 15% dropout rate, we estimated that 46 patients were needed in each group.

SPSS 26.0 statistical software was used to statistically process and analyze the data. The measurement data conforming to the normal distribution were expressed as the mean ± standard deviation, and the comparison between the groups was performed by two independent samples t test. Enumeration data were expressed by the number of patients (percentage) [n(%)], and the comparison was made by Chi-Squared Test. The comparison of measurement data that did not conform to a normal distribution was expressed by a nonparametric test and is shown as the median (25th percentile, 75th percentile).

The changes of anxiety and emergence delirium over time between two groups were evaluated by generalized linear mixed models(GLMM) with logistic link followed by pairwise comparisons with Bonferroni correction. Linear mixed model(LMM) was used to evaluate the change of pain for comparison of FLACC. Both GLMM with logistic link and LMM were adjusted for age, gender, surgery type and length of surgery and anesthesia. Taking α=0.05 as the test level, P<0.05 indicates a statistically significant difference.

Results

As shown in the Consort flow chart (Figure 1), 95 children were enrolled in our study, and 15 children were excluded because of withdrawal of consent, loss of follow-up, discontinued intervention or extra medication. Thus, 80 participants completed the study and were included in the final data analysis. There were no statistically significant differences between the groups in terms of age, gender, height, weight, duration of surgery and anesthesia or the type of surgery (Table 1).

The incidence of anxiety was significantly different over time among children (F=3.212, P=0.023). There is also a significant difference in the incidence of anxiety between group V and group C (F=34.943, P **<** 0.001)(Figure 2, Table 2). Moreover, the interaction effect between time and group

was statistically significant (F=8.126, P < 0.001)(Table 2). The incidence of anxiety at T0 exhibiting baseline anxiety was not statistically different between the groups (P = 0.323). After the intervention, the incidence of anxiety of group V is significantly lower than that of group C at T1 (P < 0.001), T2 (P < 0.001) and T6 (P < 0.001) (Figure 2) . Meanwhile, the peak mYPAS scores showed significant difference between the two groups (P<0.001) (Table 2).

The incidence of ED was significantly different over time among children (F=15.688, P < 0.001). However, the incidence of ED between the groups and the interaction effect between time and group were not statistically different (F=2.169, P=0.142; F=1.220, P=0.302). Additionally, the peak of PAED in group V was significantly lower than that in group C (P=0.016) (Table 3).

The FLACC score was significantly decreased over time among children (F=3.870, P=0.010). However, the FLACC scores between the groups and the interaction effect between time and group were not statistically different (F=0.059, P=0.808; F=1.381, P=0.249). Similarly, the ICC and the incidence of adverse events were not found to be significantly different (P=0.110, P=0.692) (Table 4).

Discussion

In the present study, we found that individual cartoon videos can significantly reduce the incidence of perioperative anxiety and alleviate ED in pediatric patients undergoing adenoidectomy and adenotonsillectomy.

As demonstrated in Figure2, the incidence of anxiety at T0 was not significantly different between the two groups. The individual cartoon video helped the children in group V reduce anxiety at T1. While the incidence of anxiety at T1 in group C was higher than that at T0. This indicates that simply watching the individual cartoon video at holding area may have been sufficient to reduce anxiety during entry into the operation room. Without the impact of intervention measure, the children in group C showed the increasing levels of anxiety. While children who watched the individual cartoon video had lower levels of anxiety at T1, T2 and T6 compared to that at T0. These findings are sufficient to demonstrate a strong benefit of individual cartoon video by reducing the anxiety of pediatric patients during the whole perioperative period.

Katherine A[12] showed that the children in the group with video distraction displayed significantly less anxiety at anesthetic induction and had a smaller increase in anxiety from the holding area to induction than those in the standard care group. This finding is consistent with our findings. We noticed that many studies focused only on preoperative anxiety and ignored the postoperative status of the patient's anxiety. In daily work, we observed that some pediatric patients often cry and scream after surgery. So we speculate that they may long for the company of their parents, which could also be a form of anxiety. In our study, we found that the pediatric patients in the control group displayed more anxiety when they departed from the PACU than the patients who watched the individual cartoon videos. As a result, the individual cartoon videos play a key role in alleviating anxiety in

the whole perioperative period.

Kain[4] pointed out an important correlation between emergence delirium and preoperative anxiety in children: for every 10-point increase in the mYPAS, the risk of delirium increases by 10%. A previous study[34] suggested that preoperative anxiety was one of the risk factors for ED. Thus, interventions aimed at alleviating preoperative anxiety are of great significance for preventing ED. However, few studies evaluated the effect of non-pharmacological approaches especially the technology devices in reducing the emergence delirium.

In our study, analyzing the emergence delirium in the generalized linear mixed models (GLMM) with logistic link, we did not find the significant difference in the groups and the interaction effect between time and group. When comparing the peak PAED scores between the groups, we found that the degree of ED in group V is significantly lower than that in group C. These results show that the individual cartoon video can only alleviate the severity of ED and fails to reduce the incidence of ED. Our study may not have been powered to fully demonstrate the association of other factors with anxiety and emergence delirium, such as age, gender, surgery type and length of surgery and anesthesia. In the study, these factors did not differ between the two groups, had no impact in the multivariable analysis, and thus did not impact our conclusions. There were no significant differences in the incidence of adverse events between the two groups. However, previous studies[35] have found that ED increases the risk of these adverse events. The possible reason is that our study may be limited by the sample size. We calculated the sample size with the incidence of ED and anxiety, and a larger sample size is required for determining differences in adverse events.

Most young children are very fond of watching cartoon videos. A favorite cartoon can immerse children in videos and distract their attention from the unfamiliar environment and the absence of their parents so that children will not cry because of fear and anxiety. Meanwhile, many popular cartoons are freely available with public access. Therefore, the intervention of watching individual cartoons to reduce anxiety can be used without increasing health care costs. Gamze Inan[36] demonstrated 3 different distraction techniques on the pain and anxiety levels of children during venipuncture, in which there are only several popular fixed options, whether in cartoon movies or video games. In our study, we did not limit the number and types of cartoon videos. We determined the patients' favorite cartoon video one day before the operation and downloaded it in advance. In this way, the intervention for anxiety will be targeted, and the effect will be maximized.

Video display for pediatric patients has been an emerging audiovisual distraction modality to reduce anxiety. Initial studies in audiovisual distraction during induction of anesthesia in pediatric patients used video games, apps and streaming video clips to demonstrate reductions in mYPAS scores[12, 16, 17]. We innovatively chose the individual cartoon video as the intervention throughout the whole perioperative period to evaluate the anxiety and ED. Thus, the purpose and findings of this study complement existing literature examining perioperative psychological and mental state of children and offer a fresh approach to relieve perioperative anxiety and ED in pediatric patients.

In terms of the strengths of this study, first of all, the individual cartoon video is an easy and effective modality which can capture children's attention to the maximum extent and is freely available with

public access. Secondly, the established outcome scales we used are validated and behavior based to reduce observer bias. Thirdly, we included a time point after surgery to evaluate the anxiety in children and ultimately confirmed that the individual cartoon video can reduce anxiety throughout the whole perioperative period.

Several limitations related to this study should also be discussed. One limitation is that the outcomes were limited to the immediate period. Though it has been proved that the negative psychological impact of perioperative anxiety can stretch beyond the perioperative period and includes maladaptive postoperative behaviors, such as separation anxiety, nightmares and eating disorders[37-40], it remains unclear whether interventions aimed at reducing preoperative anxiety would lead to a decrease in such behaviors. Besides, the sample size of study is relatively limited. We found no significant difference of adverse events between the two groups. The most likely reason is that we calculated the sample size based on the incidence of ED and anxiety. Thus, the number of children recruited may have been insufficient to detect the effects of the individual cartoon videos on postoperative adverse events. Thirdly, though the trained investigator was blinded to the group allocation before assessment, the blinding was impossible at some time points because cartoon video watching were visible to the investigator. As a result, observer bias may have influenced assessments of anxiety, emergence delirium, pain and compliance at induction of anesthesia.

On the basis of our findings, future directions for further studies include longer postoperative follow-up, larger sample size and more application fileds, including pediatric cardiovascular and cerebrovascular intervention therapies, radiological examinations and endoscopic examinations and treatments outside the operation room.

Conclusion

We concluded that the individual cartoon video was demonstrated to be an easy, effective and noninvasive modality for perioperative anxiety and emergence delirium in pediatric patients.

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Assistance with the study

none.

Author contributions

Xinyu Tang and Muchun Zhang contributed equally to this paper.

All authors contributed to the study conception and design. Material preparation and data collection were performed by Xinchen Tao, Yamei Li, Yi Wang and Xin Wang. Data analysis was conducted by Xinyu Tang and Muchun Zhang. The first draft of the manuscript was written by

Xinyu Tang and Muchun Zhang and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing interests statement

All authors declare that they have no competing interests.

Ethics Statement

This clinical trial was approved by the Ethics Committee of the Second Hospital of Anhui Medical University (Reference number: YX2022-084 (F1)) and was registered at the Chinese Clinical Trial Registry (Reference number: ChiCTR2200062300). The study was performed in accordance with the Helsinki Declaration of 1964, and its later amendments. Written consent was obtained from parents (or guardians).

Data availability statement

The data to support the results of this study is available from the corresponding author on reasonable request.

Prior presentation

none

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Table 1. Demographic and surgical characteristics of the pediatric patients between individual cartoon video group and control group

Data are presented as frequency (percentage) or mean ± SD (Standard Deviation).

[a]two independent samples t test

[b]Chi-Squared Test

Table2. Anxiety occurrence and levels in pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n = 40)	Control (n = 40)	P value
Age (years)[a]		5.75 ± 1.21	5.68 ± 1.58	0.812
Gender (male) [n (%)][b]		17 (42.5)	23 (57.5)	0.18
Height (cm)[a]		114.43 ± 9.24	108.10 ± 11.92	0.319
Weight (kg)[a]		21.47 ± 6.18	21.63 ± 5.26	0.271
Surgery length (min) [a]		34.45 ± 12.07	34.63 ± 12.20	0.596
Anesthesia length (min)[a]		47.35 ± 15.16	46.23 ± 14.09	0.691
Surgery [n (%)][b]				0.875
	Adenoidectomy	15 (37.5)	17 (42.5)	
	Tonsillectomy	10 (25)	10 (25)	
	Adenoidectomy+ Tonsillectomy	15 (37.5)	13 (32.5)	

		Individual cartoon video (n=40)	Control (n=40)	P value
Anxiety[a]				< 0.001*
	T0 [n(%)]	26(65)	22(55)	
	T1 [n(%)]	8(20)	32(80)	

	T2 [n(%)]	16(40)	36(90)	
	T6 [n(%)]	21(52.5)	35(87.5)	
Peak_mYPAS[b]		51.00 [41.67~60.89]	64.14 [53.57~85.47]	< 0.001[†]

*P_{time}=0.023 *P_{group} < 0.001 *$P_{interaction}$ < 0.001

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Generalized Linear Mixed Model(GLMM) with logistic link was adjusted for age, gender, surgery type and length of surgery and anesthesia.

[b]Mann–Whitney U-test

mYPAS, Modified Yale Preoperative Anxiety Scale

T0, preoperative holding area

T1, entry to the operating room

T2, induction of anesthesia

T6, leaving the PACU

mYPAS > 40 is considered as the occurrence of anxiety.

Peak_mYPAS refers to the highest score of mYPAS in the four time points of T0, T1, T2 and T6.

*P < 0.05 is significant in GLMM with logistic link.

[†]P < 0.05 versus the control group.

Table3. Emergence delirium occurrence and levels in pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n=40)	Control (n=40)	P value
ED[a]				0.302
	T3 [n(%)]	22(55)	31(77.5)	
	T4 [n(%)]	13(32.5)	22(55)	

	T5 [n(%)]	9(22.5)	10(25)	
	T6 [n(%)]	6(15)	5(12.5)	
Peak_PAED[b]		12.00 [9.00~13.00]	13.50 [10.00~15.00]	0.016†

*P_{time} < 0.001 P_{group}=0.142 $P_{interaction}$=0.302

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Generalized Linear Mixed Model(GLMM) with logistic link was adjusted for age, gender, surgery type and length of surgery and anesthesia.

[b]Mann–Whitney U-test

PAED, the Pediatric Anesthesia Emergence Delirium scale

T3, immediately after extubation

T4, arriving in the PACU

T5, 30 min after arriving in the PACU

T6, leaving the PACU

Peak_PAED refers to the highest score of PAED in the four time points of T3, T4, T5 and T6.

PAED≥10 is considered as the occurrence of emergence delirium.

*P < 0.05 is significant in GLMM with logistic link.

†P < 0.05 versus the control group.

Table 4. Secondary outcomes of the pediatric patients between individual cartoon video group and control group

		Individual cartoon video (n = 40)	Control (n = 40)	P value

FLACC[a]				0.249
	T3	3.00 [1.25~4.75]	3.50 [2.00~5.00]	
	T4	3.00 [1.00~5.00]	3.50 [2.00~5.75]	
	T5	2.50 [1.00~4.00]	3.00 [2.00~5.00]	
	T6	2.00 [1.00~3.75]	3.00 [1.00~4.00]	
ICC[b]		2.00 [0.00~4.00]	3.00 [1.25~4.00]	0.11
Adverse events[c] [n (%)]		3 (7.5)	4 (10)	0.692

*P_{time}=0.010 P_{group}=0.808 $P_{interaction}$=0.249

Data are presented as frequency (percentage) or median [25th percentile to 75th percentile] as appropriate.

[a]Linear Mixed Model(LMM) was adjusted for age, gender, surgery type and length of surgery and anesthesia.

[b]Mann–Whitney U-test

[c]Chi-Squared Test

FLACC, Face, Legs, Activity, Consolability, Cry scale

T3, immediately after extubation

T4, arriving in the PACU

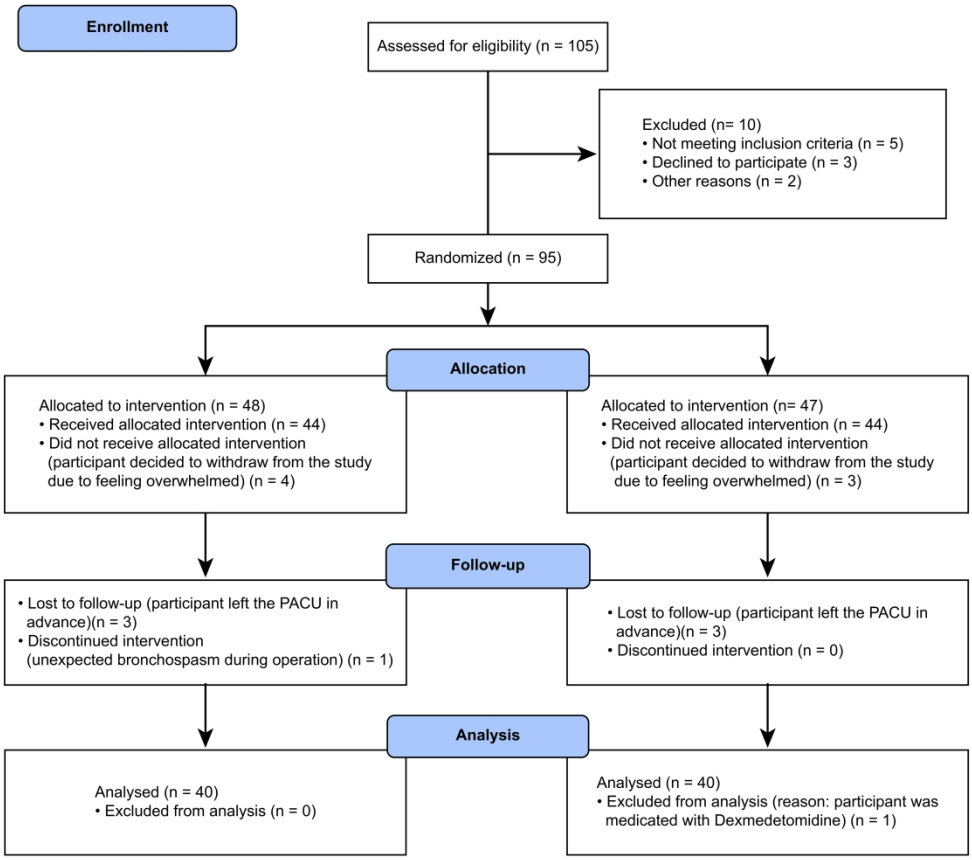
T5, 30 min after arriving in the PACU

T6, leaving the PACU

ICC, induction compliance checklist

Adverse events refer to severe hypoxemia, bronchospasm, postoperative bleeding, etc.

*P < 0.05 is significant in LMM.



CONSORT flow diagram of the study.

179x157mm (580 x 580 DPI)

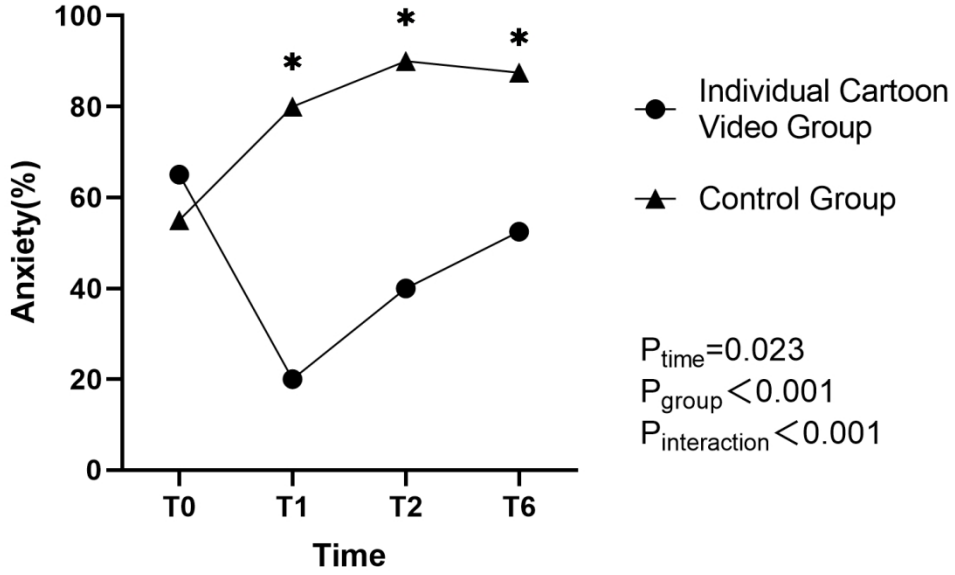


Figure2: Anxiety occurrence in pediatric patients in the perioperative period
□P<0.001 versus the control group
T0, preoperative holding area
T1, entry to the operating room
T2, induction of anesthesia
T6, leaving the PACU
mYPAS>40 is considered as the occurrence of anxiety.

132x84mm (300 x 300 DPI)