

## Original Research Article

# Monitored care during anesthesia with remifentanyl and lidocaine in pediatric strabismus surgery: A single-center experience

Shili Zhu, Shuangquan Qu\*, Jiangping Wang

Department of Anesthesiology, Hunan Children's Hospital, Hunan, China

\*For correspondence: **Email:** 445437884@qq.com; **Tel:** +86-013607489215

Sent for review: 19 October 2022

Revised accepted: 24 February 2023

### Abstract

**Purpose:** To evaluate the use of monitored anesthesia care (MAC) in pediatric strabismus surgery.

**Methods:** A total of 17 cases undergoing strabismus surgery with MAC were included in this study. The protocol for sedation was standardized and data were collected prospectively for an ongoing quality assurance project. Intravenous channels were established in the ward for all the children, and penehyclidine 0.01 mg/kg and ondansetron 0.1 mg/kg were injected intravenously. After communicating with children the second time, 0.05 mg/kg midazolam, 0.1 µg/kg sufentanyl, and 2 mg/kg propofol were injected intravenously. Continuous intravenous pumping of remifentanyl 0.1 ~ 0.2 µg/kg/min while local infiltration anesthesia was performed with 1 % lidocaine after the loss of consciousness.

**Results:** It took  $7.0 \pm 3.5$  min to wake up successfully. There was no nausea, vomiting, or delirium after the operation. The children had good postoperative recovery and no bad memories, and they and their families were highly satisfied with the surgery.

**Conclusion:** Local anesthesia and MAC produces satisfactory sedation in most patients without switching to general anesthesia. However, it has to be fully demonstrated that MAC local anesthesia is superior to general anesthesia in pediatric strabismus surgery via multi-centered studies.

**Keywords:** Monitored anesthesia care, General anesthesia, Strabismus surgery

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## INTRODUCTION

Strabismus (skewness) is a common pediatric ophthalmic disorder that affects 2 to 4 % of normally developing children. Strabismus surgery is one of the most common eye operations performed under general anesthesia [1]. Over-correction and under-correction may occur in 10 - 15 % of strabismus surgeries [2], but the use of adjustable suture techniques and intraoperative

awake testing reduces the incidence of over-correction or under-correction [3]. So, some strabismus patients need to be woken up during the operation procedure to ensure a better result.

Monitored Anesthesia Care (MAC) is a concept recently proposed by the American Society of Anesthesiologists (ASA), and indications for monitored anesthesia care include the nature of the procedure, the patient's clinical situation,

and/or the potential need to switch to general or local anesthesia. The MAC represents a continuum of anesthesia care, from waking to potential intubation [4]. Administered and monitored by anesthesiologists, it is a unique anesthesia method that combines intravenous sedation, analgesia, and regional anesthesia [5]. At present, it has been used by scholars for implantation of subcutaneous cardioversion defibrillators [6], gastroenteroscopy [7], and thyroidectomy [8]. However, it is difficult for children to receive local anesthesia surgery in an awakened state.

Monitored anesthesia care was applied in infants and children during cardiac catheterization and without significant effects on cardiovascular or ventilatory function [6], so MAC was applied to children received anesthesia surgery, which not only ensures the comfort and safety of patients but also enables children to cooperate with the doctor's guidance to ensure the surgical effects in this study.

## METHODS

### Study design

This was a single-center, non-randomized descriptive study of outcomes in 17 children aged 5 to 12 years, including 7 males and 10 females, who received strabismus or ptosis correction surgery with MAC at the Hunan Children's Hospital between January 2020 and January 2021. The study was approved by the local institutional review board (approval no. HCHLL-19-45). The study was conducted by following the Declaration of Helsinki [9]. All strabismus surgeries were carried out in the daytime and would commence before 9 am in accordance with the Centers' Day surgery policy. All patients had the following minimum fasting time: heavy meal 8 h, light meal and non-human milk 6 h, clear liquid 2 h. They were given intravenous fluids before induction of anesthesia and lactate Ringer's solution before and during anesthesia. The children had no mental or neurological diseases or systemic diseases.

### Exclusion criteria

Those with history of allergies and malignant hyperthermia, current use of antiepileptic medications, known myasthenia gravis, myasthenia syndrome, neuromuscular disease, arrhythmias, moderate cardiovascular, pulmonary, hepatobiliary or renal disease, or overweight (body mass index > 85th percentile) were excluded from the study.

The researchers communicated with the children and their families before surgery, and those who could cooperate with the operation were selected. Informed consent for anesthesia was signed before surgery, and general anesthesia was changed when the children could not cooperate to complete the operation.

### Administration of anesthesia

Intravenous routes were established in the ward for all the children, and penehyclidine (0.01 mg/kg) and ondansetron (0.1 mg/kg) were injected intravenously. After communicating with the children, 0.05 mg/kg midazolam, 0.1 µg/kg sufentanil and 2 mg/kg propofol were injected intravenously followed by intravenous continuous pumping of remifentanil 0.1 ~ 0.2 µg/kg min. Local infiltration anesthesia was performed with 1 % lidocaine after loss of consciousness. During the operation, oxygen was given using mask, and a nasopharyngeal airway was placed when the mask was difficult to ventilate, to ensure that the oxygen saturation of the finger pulse was above 95 %.

### Intraoperative awakening

Base on the American Society of Anesthesiologists (ASA) recommendations for MAC, many factors are considered in the decision-making process, including but not limited to [10]: distorted head and neck anatomy prediction, difficulty in intubation, history of difficulty in intubation, poorly controlled gastroesophageal reflux, obesity, history of obstructive sleep apnea, history of moderate-to-severe pulmonary hypertension, baseline hemodynamics, and inability to directly access the patient's airway during surgery. The operation was started with local infiltration and anesthesia. An appointment was made by the surgeon to notify the anesthesiologist 10 min before, of the need for awakening.

The pumping rate of remifentanil was lowered to 0.05 µg/kg/min, and after the operation, the operator began to wake up the child and also asked the child to move the eyes as instructed. After awakening, 0.1 µg/kg of sufentanil was given, as well as 2 mg/kg of propofol, and the remifentanil pumping rate was adjusted to 0.1 ~ 0.2 µg/kg/min to make the children fall asleep. At the end of the operation, the remifentanil pump was stopped. If the children woke up after their eyes were wrapped, the nasopharyngeal airway was pulled out and the children were sent to PACU. Those unable to wake up were sent to PACU with the nasopharyngeal airway.

## Parameters evaluated

Philips MX550 was used to monitor ECG, non-invasive blood pressure, finger pulse oxygen saturation and respiratory rate. Agitation, respiratory depression, nausea and vomiting were monitored within 24 h after the operation, and the children were asked whether they had bad memories of anesthesia and the operation process.

## Statistical analysis

Data are analyzed using Microsoft Excel spreadsheet. Descriptive analyses were performed and values are reported as mean  $\pm$  standard deviation (SD).

## RESULTS

A total of 17 patients were included in this study, ranging in age from 5 to 12 years, with a mean age of  $9.4 \pm 2.2$  years, including 7 males and 10 females. Their mean height was  $135.4 \pm 9.0$  cm, and mean weight was  $24.4 \pm 3.1$  kg (Table 1).

**Table 1:** Demographic characteristics of the study population

Characteristic	Cases
Age (years)	$9.4 \pm 2.2$
Sex (M/F)	7/1
Height (cm)	$135.4 \pm 9.0$
Weight (kg)	$24.4 \pm 3.1$

The duration of surgery was presented as mean  $\pm$  SD 22 (16 – 27.75) min and the duration of anesthesia (min) was about  $40.8 \pm 10.9$  min. It took  $7 \pm 3.5$  min to wake up successfully. There were 4 children (23.53 %) with respiratory depression after induction of anesthesia, and they were treated with manual ventilation via mask. After about 10 times of assisted breathing, spontaneous breathing was recovered, and the mask well ventilated. There were 6 cases with obvious posterior tongue drop. After lubrication with lidocaine cream and anesthesia, nasopharyngeal airway was placed, and obstruction was relieved (Table 2).

There was no nausea or vomiting after operation. The Pediatric Anesthesia Emergence Delirium (PAED) score or pain score (Children's Hospital of Eastern Ontario Pain scale, CHEOPS) were assessed at the postanesthetic care unit. Delirium was defined as PAED score  $\geq 12$  at any time point in the PACU. The mean score of PAED was 9.0 (0 – 12.0) points at 20 min after PACU in, and 5 (0 – 11.0) points at PACU out. The mean score of CHEOPS was 9 (4.0 – 11.0)

at PACU in, and 7.0 (4.0 – 9.75) at PACU out (Table 3).

**Table 2:** Perioperative data

Characteristic	Cases
Duration of surgery (min)	22 (16–27.75)
Duration of anesthesia (min)	$40.8 \pm 10.9$
<b>Intraoperative hemodynamic parameters</b>	
Heart rate (bpm)	$128 \pm 17$
Systolic blood pressure (mmHg)	$92 \pm 9$
Diastolic blood pressure (mmHg)	$47 \pm 6$
Mean blood pressure (mmHg)	$65 \pm 6$
Wake up time (min)	$7 \pm 3.9$
Time from surgery end to PACU admission (min)	$6.0 \pm 2.3$
PACU stay time (min)	$20.4 \pm 9.4$
Posterior tongue drop	6 (35.29 %)

**Table 3:** Complications in anesthesiology data

Characteristic	Cases
PONV	0 (0 %)
Respiratory depression	4 (23.53 %)
<b>CHEOPS score</b>	
PACU in	8.0 (4.0 – 11.0)
30 min	8.0 (4.0 – 8.0)
PACU out	7.0 (4.0 – 9.75)
<b>PAED score</b>	
PACU in	13.0 (0 – 18.0)
10 min	12.0 (0 – 13.0)
20 min	9.0 (0 – 12.0)
30 min	8.0 (0 – 11.0)
PACU out	5 (0 – 11.0)

Children had a good postoperative recovery, had no bad memory, and their families satisfactory surgical effect (Table 4).

**Table 4:** Postoperative situation

Item	Cases
Bad memory	0 (0%)
Patient's satisfaction (good/so so/bad)	12/4/1
Surgeon's satisfaction (good/so so/bad)	13/4/0

## DISCUSSION

It is difficult for children to undergo surgery under local anesthesia due to the fear of unfamiliar environments and surgical procedures. For some complex strabismus operations, it may not be possible to accurately calculate the amplitude of each muscle adjustment before surgery, but to calculate and adjust the operation by observing the position and activity of the eyeball after adjusting part of the muscle during the operation. At this time, the children under general anesthesia cannot cooperate with the requirements of the surgeon, so that some children are not satisfied with the degree of correction, necessitating a second operation,

which not only reduces the satisfaction of the children and their parents, but also increases the burden on the children's families and hospital staff.

During eye surgery under general anesthesia, the eyes were bandaged after surgery, resulting in vision loss [11]. In addition, postoperative children were not fully awake. The recovery period after general anesthesia, during which consciousness and pain gradually return, essentially depends on the choice of anesthetic drug and the total dose or duration of the anesthetic drug. This stage is often complicated by more or less severe agitation, especially in children [12]. The emergence of agitation is a common postoperative adverse complication in children, especially children who underwent strabismus surgery [13]. Although the mechanism of delirium after general anesthesia is unclear, there are well-known risk factors such as young age, previous surgical history, eye surgery, ear, nose and throat surgery, use of volatile anesthetics (such as sevoflurane), preoperative anxiety, etc [13,14]. In this study, in children who received MAC, the PAED scored less than 12, and after PACU for 20 min, MAC reduced the PAED score when compared with other literatures using general anesthesia [15].

There are many ways to provide anesthesia care for patients undergoing eye surgery. Anesthesia plans range from moderate sedation to monitored anesthesia care, to general anesthesia. The use of local and regional anesthesia improves anesthesia techniques that facilitate eye surgery while providing good patient care [11]. The MAC technology helps the child to feel safe and comfortable in that operative environment via the intravenous infusion of sedative and analgesic drugs, so that the child can be operated under local anesthesia without a bad memory of the operation process. At the same time, because the drug dose of general anesthesia is not large, the children can quickly wake up from the sedation, cooperate with the instructions of the operator and complete the intraoperative examination. All the children in this study achieved the expected results from surgery, and the surgeon, the children and their parents were satisfied. This study describes cases of strabismus surgery in children using MAC under local anesthesia.

The main advantages of general anesthesia are total loss of consciousness, stable surgical field of vision, and airway control. However, general anesthesia prolongs postoperative recovery time, and can lead to hemodynamic instability during anesthesia induction. In contrast, MAC aids quick

recovery after local anesthesia. According to literature reports, the incidence of agitation after ophthalmic surgery is up to 40 - 86 % [16]. In this study, the postoperative Ramsay score was maintained at 2 - 5 points. After 30 min observation in PACU, the children had no respiratory depression, no nausea and vomiting, and were returned to the ward after Ramsay score was greater than 4 and Aldrete score was greater than 9. None of the patients showed postoperative agitation.

However, the use of sedative and analgesic drugs increases the difficulty of respiratory management. In this study, there was a child who complained of unbearable pain after the operation, and the additional dose of sufentanil and propofol was large. The tongue fell back during the operation, which required the operator to terminate the operation and continue after the placement of nasopharyngeal airway. Therefore, a proper nasopharyngeal airway and endotracheal intubation must be prepared before MAC is implemented.

### **Limitations of this study**

This report is a preliminary study of a new anesthetic method for strabismus surgery in children. However, it cannot be fully demonstrated whether MAC local anesthesia is superior to general anesthesia in pediatric strabismus surgery. This case report does not have a sufficient number of subjects to make definitive recommendations on this topic without a control group.

### **CONCLUSION**

This work has demonstrated the possibilities of using this new method of surgical anesthesia for strabismus in children. This case report provides pilot data or clinical protocols for further study of strabismus surgery in children with MAC under local anesthesia. Under the guidance of an experienced surgeon and anesthesiologist, MAC may be performed safely under local anesthesia for strabismus surgery in children, and may be a simple and reasonable alternative to general anesthesia.

### **DECLARATIONS**

#### **Acknowledgements**

None provided.

#### **Funding**

None provided.

### Ethical approval

This study was approved by the review board of Hunan Children's Hospital, Hunan, China (approval no. HCHLL-19-45).

### Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Conflict of Interest

No conflict of interest associated with this work.

### Contribution of Authors

We declare that this work was done by the authors named in this article and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. Shili Zhu participated in the concept and design of the study. Shuangquan Qu searched and collected the data. Shuangquan Qu performed the analysis, while Jiangping Wang wrote the manuscript. Shili Zhu revised the manuscript and gave final approval of this manuscript.

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