Application of fast-track anesthesia in percutaneous transcatheter closure of patent foramen ovale under transesophageal echocardiography

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Abstract

Objective : To analyze the application value of fast-track anesthesia in percutaneous occlusion of patent foramen ovale under transesophageal echocardiography. Methodology: 60 cases of patients with patent foramen ovale were randomized into two groups to receive either fast-track anesthesia(Group R) or conventional anesthesia(Group S).Record MAP and HR before anesthesia (T0), tracheal intubation (T1), start of surgery (T2), end of surgery (T3), exit anesthesia recovery room (PACU) (T4), as well as the operation time, anesthesia time , Recovery time of extubation, PACU stay time, recovery period agitation score, pain score VAS out of the anesthesia recovery room (PACU), incidence of adverse reactions. Results: There was no statistically significant difference in the anesthesia time and operation time between the two groups, MAP and HR before and after anesthesia between the two groups were not statistically significant different. There was statistically significant difference in recovery of spontaneous breathing, extubation time, PACU stay time, postoperative restlessness score,and incidence of adverse reactions. Conclusion: Fast-track anesthesia in percutaneous transcatheter closure of patent foramen ovale under transesophageal echocardiography can provide faster recovery of spontaneous breathing, earlier extubation time, shorter PACU stay time, lower postoperative restlessness score, lower incidence of adverse reactions.

Introduction

Patent foramen ovale ((PFO)) is the most common congenital heart disease in adults. In recent years, a large number of studies have shown that patent foramen ovale may be an important risk factor for cryptogenic stroke, which is closely related to the attack of migraine [1] . Percutaneous transcatheter closure of patent foramen ovale is considered as a first-line treatment for PFO because of its minimal trauma and rapid recovery.In the past, it was often performed in the intervention room, which increased the risk of X-ray exposure for the operators and patients.Transesophageal echocardiography (TEE)-guided percutaneous closure of patent foramen ovale solved this problem. However, placing TEE probe under local anesthesia can cause nausea and vomiting. It increases the risk of heart perforation or cardiac tamponade caused by body movement[2]. Therefore, TEE-guided Percutaneous closure of the foramen ovale is preferred under general anesthesia. Because of its short operation time and fast turnover, it puts forward higher requirements for anesthesia management in order to shorten the extubation and PACU stay time.Fast-track anesthesia can maintain the hemodynamic stability of patients, realize early extubation and shorten hospitalization time [3-6]. However, there are few reports on the application of fast-track anesthesia in patent foramen ovale occlusion. The purpose of this study is to explore the anesthetic effect of fast-track anesthesia in percutaneous patent foramen ovale occlusion under esophageal echocardiography.

2.Methods

This study was approved by the Ethics Review Committee of Yongchuan Hospital affiliated to Chongqing Medical University(2019 Collen trial 30)

2.1 Study population

60 patients with patent foramen ovale were recruited from the Department of Anesthesiology, Yongchuan Hospital, Chongqing Medical University. including 26 males and 34 females, ranging in age from 18 to 65 years old. This study was carried out under the premise of patients' informed, voluntary and consent participation, and the informed consent form was signed by the patient or his family before operation. ASA grade I ˜ III. Patients with heart, liver, brain, lung, kidney, metabolic and central nervous system diseases, pregnancy, and known drug allergies were excluded.

The sample size for this study was calculated by the PASS 15.0 software as 60 patients: randomized by a computerised random number generator into 2 groups of 30 patients. Group R: fast-track anesthesia; and Group S: conventional anesthesia. The anesthesiologist and data collectors were unaware of the individual groups and content of the syringes. All eligible patients were included in the study.

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2.2 Data collection

After admission, pulse oxygen saturation, electrocardiogram and invasive blood pressure were measured in all patients. Both groups were given Penehyclidine hydrochloride 0.5mg and dexamethasone 10mg before anesthesia. Group R was induced with remifentanil 2ug/kg and Group S was induced with sufentanil 0.4ug/kg. Both groups were given midazolam 0.05 mg/kg + propofol 2mg/kg + rocuronium 0.6mg/kg for anesthesia induction. Group R anesthesia maintenance: remifentanil 0.2-0.4ug/kg·min+ propofol 2-4mg/ (kg·h) + 1%-2% sevoflurane continuous inhalation, Group S anesthesia maintenance: sufentanil 0.3-0.5ug/kg·h + propofol 2-4mg/ (kg·h) + 1%-2% sevoflurane continuous inhalation. After induction of 3min, Group R and S received mechanical ventilation with tracheal intubation. The oxygen flow was set to 2L, tidal volume was 6-8ml/kg, respiratory rate was 12-14times / min, inspiratory / expiratory ratio was 1 / 2, end-expiratory partial pressure of carbon dioxide (PetCO2) was maintained at 35-45mmHg,BIS was maintained at 40-60,and rocuronium was injected intravenously intermittently. When HR was less than 50 beats / min, atropine 5mg was injected intravenously, MAP< 65mmhg, and ephedrine 10mg was injected intravenously.During the operation, TEE was used to visually confirm the position of the occluder and place it. Stop using all anesthetic drugs when pressing the puncture point of the femoral vein to stop bleeding. At the end of the operation, the endotracheal tube was extubated when the patient reached the indication of extubation.

2.3 Observation index

MAP HR before anesthesia (T0), endotracheal intubation (T1), beginning of operation (T2), end of operation (T3), out of anesthesia recovery room(PACU) (T4), operation time, anesthesia time, awakening and extubation time, PACU stay time, incidence of adverse reactions, postoperative restlessness score(PAED) (score criteria: 0 points: no agitation, 1 3 points: slight agitation, relieved after language comfort; 4 points: agitation or self-extubation without external stimulation, 5 points: severe agitation, need pression), visual analog score (VAS) (score: evaluate the degree of pain, the total score is 0-10,painless is 0, severe pain is 10.)

2.4 Statistics

SPSS (Statistical Package for Social Sciences) version 26.0 was used to process the data,The chi-square test is used to compare frequencies using two independent sample T-tests to compare the differences between the two sets of normally distributed result variables. A p-value < 0.05 indicates that the difference is statistically significant.Logistic regression was used for analyzing incidences of incidence of adverse reactions.

3.Results

3.1 Comparison of gender , age, weight between the two groups

There was no significant difference in sex, age and body weight between the two groups (P > 0.05).

Table 1.

	Gender (male / female)	age	weight
GroupR	7/23	44.3±7.2	59.9±6.0
GroupS	5/25	44.4±8.1	58.4±6.1
p-value	0.53	0.97	0.35
t-value	0.34	0.64	0.94

3.2 Comparison of MAP and HR detection results between the two groups at different points

There was no significant difference in MAP and HR between the two Groups during T0 T1 T2 T3 T4 .(Table1)

Table2.

	Group	T0	T1	T2	T3	T4
MAP	**GroupR**	93.0±10.7	82.7±9.2	82.3±11.4	80.6±11.6	95.4±10.3
	GroupS	96.2±14.1	83.6±13.5	85.4±13.0	82.2±18.1	94.8±10.5
	p-value	0.33	0.76	0.32	0.68	0.82
	t-value	0.98	0.31	1.00	0.42	0.24
HR	**GroupR**	75.3±11.5	69.2±9.6	70.7±10.9	67.4±11.8	74.4±11.3
	GroupS	73.7±11.6	67.6±9.9	69.0±11.9	63.9±9.1	73.2±10.3
	p-value	0.60	0.53	0.56	0.20	0.67
	t-value	0.54	0.64	0.59	1.3	0.43

3.3 Operation time, anesthesia time, awakening and extubation time, PACU stay time of the two groups

There was no significant difference in operation time and anesthesia time between the two groups (P > 0.05). The time of awakening and extubation and the stay time of PACU in Group R were shorter than those in Group S (P < 0.05).(Table 2)

Table 3.

	Operation time	anesthesia time	Extubation time	PACU time
GroupR	35.0±16.7	68.4±15.3	24.4±8.0	51.9±9.4
GroupS	38.3±13.0	69.2±12.8	28.6±6.0	56.8±6.1
p-value	0.40	0.82	0.02	0.02
t-value	0.84	0.23	2.33	2.38

3.4 comparison of Agitation score, visual analogue score (VAS) .

The agitation score of Group R was significantly lower than that of Group S(P<0.05), and the visual analogue score (VAS) had no significant difference (P>0.05).(Table 3)

Table 4.

	Agitation Score	VAS Score
GroupR	1.9±0.8	1.53±0.73

GroupS	3.0±0.9	1.47±0.73
p-value	0.00	0.73
t-value	4.96	0.35

3.5 incidence of adverse reactions (cough, nausea or vomiting,)

The incidence of adverse reactions such as cough, nausea or vomiting,sore t-hroat in Group R was lower than that in Group S.(Table 4)

Table 5.

	cough	**vomiting**
GroupR	0 cases(0%)	1 cases(3.3%)
GroupS	3 cases(10%)	2 cases(6.7%)
p-value	/	/
t-value	/	/

Discussion

Although patent foramen ovale has little effect on hemodynamics, it often causes right-to-left shunt, so that embolic substances can enter the arterial system from the venous system, resulting in contradictory embolic diseases such as occult stroke and transient ischemic attack[7].Percutaneous transcatheter closure of patent foramen ovale has become a first-line treatment for PFO because of its unique advantages, such as short operation time, rapid postoperative recovery, short hospital stay and so on.TEE-guided percutaneous closure of patent foramen ovale avoids X-ray exposure in intervention room. General anesthesia can avoid discomfort and pain caused by TEE positioning and examination during local anesthesia, and avoid the risk of heart perforation or cardiac tamponade caused by body movement to the greatest extent.Tachyarrhythmia is prone to occur during this kind of operation. Strengthening the control of ventricular rate and maintaining circulatory stability are the key points of anesthesia management.Meanwhile, due to the minimally invasive and fast turnaround characteristics of the operation itself, it is very important to choose an appropriate anesthesia method and anesthetic to facilitate recovery and extubation as soon as possible after the operation.This coincides with the concept of fast-track anesthesia[8-10]:reduce the use of opioids or combining short-acting opioids with other short-acting muscle relaxants or anesthetic techniques to achieve appropriate anesthetic effects.It is found that fast-track cardiac anesthesia can effectively maintain the hemodynamic stability of patients, realize early extubation, reduce postoperative complications, shorten hospitalization time, reduce hospitalization expenses and effectively improve the prognosis of patients[3-6].

Remifentanil and sufentanil are commonly used opioids in general anesthesia.In 534 patients who received fast track anesthesia,Groesdonk[11] found that ultra-short-acting opioid drugs will not cause intraoperative awakening.In 65 children who undergoing minimally invasive closure of ventricular septal defect, Wang ZC[12] found that fast-track anesthesia with sufentanil was proved to be safe and effective compared with fentanyl, and reduced hospitalization costs.In 62 children who undergoing transthoracic closure of ventricular septal defect, XuN[13] found that there was no significant difference in intraoperative hemodynamic changes, EEG bispectral index, postoperative analgesia score and sedation score between fast-track anesthesia with remifentanil and conventional anesthesia.In this study, there was no significant difference in MAP and HR between the two groups, which was consistent with the findings of Wang Z C and Xu N.It is suggested that both remifentanil and sufentanil can provide sufficient analgesia and inhibit surgical stress response during percutaneous transcatheter closure of patent foramen ovale under TEE, and have little effect on hemodynamics.Huang Q[14]found that during transcatheter closure of atrial septal defect, Compared with 72 cases of fast-track anesthesia with remifentanil and 80 cases of fentanyl conventional anesthesia group. The mechanical ventilation time (1.1hVS3.4h), hospital stay (1.8d VS 3.2d), hospitalization cost (27,000 VS 38,000) and the incidence of pulmonary infection (4.2% VS 13.8%) and bronchospasm (0% VS 6.3%) in

fast-track anesthesia with remifentanil group were significantly lower than those in the fentanylconventional anesthesia group.This may be because remifentanil's special ester bond is easily decomposed into inactive metabolites by non-specific esterase in plasma and tissues, which makes remifentanil the fastest metabolizing drug in fentanyl family. In addition, its clearance does not depend on liver and kidney , even if it is infused intravenously for a long time, it has no accumulation effect, and it can recover quickly after stopping medication, so it generally does not produce postoperative respiratory depression, and can be quickly extubated. This makes the controllability and safety of anesthesia significantly improved, which is beneficial to the implementation of fast-track anesthesia.Xu N[15] found that compared with sufentanil, fast-track anesthesia with remifentanil can shorten the time of mechanical ventilation (2.6h VS 3.4h), intensive care unit (5.8h VS 10.7h) and hospital stay (2.1d VS 4.4d) in 59 adult patients undergoing transcatheter closure of thoracic ventricular septal defect.Our research also found that remifentanil has advantages in shortening extubation time and staying time in PACU compared with sufentanil. This may be due to the fact that sufentanil is a highly lipophilic opioid with a high plasma protein binding rate. Compared with remifentanil, the elimination half-life of remifentanil is obviously increased, so it is easy to lead to slow recovery of respiration and obvious delay of regain consciousness after general anesthesia.Zakhary WZA[16] retrospectively compared 1218 patients undergoing remifentanil and sufentanil fast-track cardiac surgery, and found that the average visual simulated pain score of sufentanil group was lower than that of remifentanil group (1.5 vs 2.4); The consumption of pyrazole amide is less (2.6 mg vs 18.9 mg); However, the demand for postoperative analgesia in remifentanil group increased.However, in our study, there was no significant difference in postoperative agitation and pain scores between the two groups ($P > 0.05$).This may be due to the fact that percutaneous closure of patent foramen ovale is less traumatic and requires less analgesia.Emad[17] found that the incidence of nausea and vomiting after tracheal extubation was relatively lower in 300 patients undergoing fast-track cardiac anesthesia, and there was no need for prophylactic application of antiemetics before or after anesthesia. However, we found that sufentanil was more prone to cough during induction, and the incidence of postoperative nausea and vomiting was higher than that of remifentanil. This may be due to the existence of a certain number of opioid receptors in respiratory tract, which can cause cough and bronchospasm [18].Severe cough reaction can lead to reflux aspiration of stomach contents, obvious circulation fluctuation,even cardiovascular accidents and spontaneous pneumothorax. Remifentanil can reduce the incidence and severity of cough, which has been reported in the literature [19].

Sevoflurane, a volatile anesthetic, is becoming more and more popular because of its potential cardioprotective effect. Hemmerlint[20] found that sevoflurane has little effect on cardiac contractility and hemodynamics.Compared with isoflurane, sevoflurane can recover from anesthesia more quickly.In addition, the concept of fast-track anesthesia requires the use of non-depolarized muscle relaxants with short action time to reduce postoperative residual muscle paralysis and achieve immediate or early extubation. Rocuronium bromide is recommended for neuromuscular block in fast-track anesthesia[21].

Fast-track anesthesia can maintain hemodynamic stability and achieve better anesthetic effect during TEE-guided percutaneous closure of patent foramen ovale. Remifentanil combined with sevoflurane-rocuronium can not only extubate earlier and shorten PACU stay time, but also have lower incidence of adverse reactions such as cough, nausea and vomiting.

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