

Influences of cisatracurium besylate and vecuronium bromide on muscle relaxant effects and electromyography of tracheal intubation under general anesthesia

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Abstract. – OBJECTIVE: To observe the influences of atracurium besylate and vecuronium bromide on muscle relaxant effects and electromyography of patients with tracheal intubation under general anesthesia in thyroid surgery.

PATIENTS AND METHODS: 120 patients treated with thyroid surgery were randomly divided into group A and group V. Patients in group A were administered with cisatracurium besylate combined with propofol and fentanyl for induction of tracheal intubation under general anesthesia. Patients in group V were administered with 0.10 mg/kg vecuronium bromide combined with propofol and fentanyl for induction of tracheal intubation under general anesthesia. Then, the amplitude in electromyography was observed 30-70 min after I.V. muscle relaxant medicine to record the time for patients to reach 0% TW convulsion in abductor *pollicis* muscle and to observe the muscle relaxant effects.

RESULTS: There was no statistical difference in the time to reach 0% TW in two groups ($p>0.05$). After 30 min of injection of muscle relaxants, EMG positive rate and TW value in group A were significantly higher than those in group V ($p<0.05$). After 50-70 min of injection of muscle relaxants, EMG positive rate of patients in two groups was up to 100%, and EMG amplitude in group A was significantly higher than that in group V ($p<0.05$). The time of taking muscle relaxant effects in group A was significantly faster than that in group V ($p<0.05$), while the recovery time of autonomous respiration and the time of autonomous body activity in group A were slightly lower than those in group V ($p>0.05$). There was no statistical difference in the time of eye-opening of both groups ($p>0.05$). MAP and HR of patients in both groups showed no statistical difference before and after injection ($p>0.05$).

CONCLUSIONS: Average EMG amplitude and the positive rate of effective EMG amplitude of cisatracurium besylate are all higher than those of vecuronium bromide. With faster effects and shorter action time, cisatracurium besylate is more suitable in thyroid surgery IONM (intraoperative neurophysiological monitoring).

Key Words

Cisatracurium besylate, Vecuronium bromide, Electromyography.

List of Abbreviations

Intraoperative neuromonitoring = IONM; recurrent laryngeal nerve = RLN; electromyography = EMG; intensive care unit = ICU; twitch = TW; mean arterial pressure = MAP; heart rate = HR; time of flight = TOF.

Introduction

At present, medical technology is continuously developing and improving, and various muscle relaxant medicines are prepared and applied in clinical to bring huge convenience to clinical work^{1,2}. The safe, effective, and rational use of non-depolarizing muscular relaxant is always the key in clinical anesthesia. A common complication in thyroid surgery is recurrent laryngeal nerve (RLN) injury, while intraoperative neuromonitoring (IONM) can effectively avoid such injury^{3,4}. Intraoperative neuromonitoring cannot only identify and locate RLN injury, but also evaluate the vocal cords functions after operation⁵. However, the administration of muscle relaxant in operation may weaken the signal of IONM electromyography (EMG) and affect the results of IONM⁶. Clinical studies⁷ verified that without assistance of muscle relaxant, organ intubation can only be completed with more anesthesia dosage and deeper anesthesia depth, while hemodynamics may be inhibited to increase the anesthesia risk. As the assistant drug

for general anesthesia and sedation in intensive care unit (ICU), cisatracurium besylate can relax the skeletal muscle for the convenience of trachea intubation and mechanical ventilation. Vecuronium bromide is mainly used to assist general anesthesia for the convenience of trachea intubation and skeletal muscle relaxant in operation^{8,9}. This work aims at discussing the influences of cisatracurium besylate and vecuronium bromide on muscle relaxant effects and electrocardiogram for tracheal intubation under general anesthesia of patients taking thyroid surgery.

Patients and Methods

Patients

120 patients treated with thyroid surgery in our hospital from January 2011 to January 2013 were selected. There were 45 male patients and 75 female patients in age of 20-58 years old. All of these patients were randomly divided into group A and group V, and each group had 60 patients. Inclusion criteria: patients approved and signed informed consent; body mass index of patient was 20-23 kg/m²; airway was normal with Mallampati grading in level I or II. Exclusion criteria: patients with paralysis of vocal cord and diseases in neuromuscular system and cardiovascular diseases; patients with anesthetic drug allergy history¹⁰. Gender, age, height, weight, and other basic data of patients in both groups have no statistical difference ($p>0.05$) (Table I).

Measures of Anesthesia and Muscle Relaxant Monitoring

Instrument and drugs: muscle relaxant monitor (Ireland Organon, TOF-Watch SX, Pudong, Shanghai, China); cisatracurium besylate (10 mg/vial, Jiang Su Heng Rui Medicine Co., Ltd, Lianyungang, Jiangsu, China); vecuronium bromide (4 mg/vial, Zhejiang Xianju Pharmaceutical Co., Ltd, Xianju, Zhejiang, China). All the patients showed veins in the left forearm, while muscle

relaxant monitor was placed in the right forearm. Monitoring electrode was fixed with tape, and the palm was fixed on hand plate to avoid interference in monitoring for palm moving. Induction of intravenous general anesthesia: propofol 2 mg/kg and fentanyl 40 ug/kg. After the patient was unconscious, TOF calibration with muscle relaxant monitor was implemented in frequency of 2 Hz, cycle of 15 s, stimulus intensity of 50 mA. 25% TW and 0% TW were corresponding to 75% and 100% neuromuscular transmission retardation, respectively. Patients in group A were administered with 0.15 mg/kg cisatracurium besylate and that in group V with 0.1 mg/kg vecuronium bromide by intravenous injection rapidly. The specification of endotracheal tube was the enforced endotracheal tube of electromyography. Guided by visual laryngoscope, the center in blue area of catheter contacted with vocal cord. The catheter was fixed at the right mouth, and grounding electrode and loop electrode were retained in the appropriate subcutaneous location in both shoulders to avoid lung puncture. Moreover, the location was close to vocal cord and nerves, reducing the interference of signal transmission. After trachea intubation, 0.01 mg·kg⁻¹·h⁻¹ remifentanyl was pumped and 2-3% sevoflurane inhaled by intravenous to keep anesthesia. It was estimated that the effective signal in operation (positive EMG amplitude) was RLN EMG action potential >100 uV. 30-70 min after muscle relaxant injection, the EMG signal measured every 5 min.

Observational Parameters

(1) Monitoring index: TW value 30-70 min after injection, rate of positive EMG amplitude, and the time from muscle relaxant by intravenous injection to 0% TW. (2) Muscle relaxant effects: muscle relaxant effective time (from the time completing muscle relaxant injection to the time that patients had no autonomous breath and muscular relaxed in the whole body without limb movement); recovering autonomous breath time (from the time completing anesthesia induction

Table I. Comparison of clinical data between group A and group V.

Groups	Cases	Gender (Male/Female)	Age	Body-Height (cm)	Body-Weight (kg)
Group A	60	23/37	37.7±4.1	159.35±10.36	57.78±6.45
Group V	60	22/38	38±4.3	159.32±10.33	57.48±6.29
Test value		$\chi^2=0.04$	$t=0.391$	$t=0.016$	$t=0.258$
<i>p</i> -value		0.850	0.696	0.987	0.797

Table II. The effect of muscle relaxation of patients in group A and group V ($\bar{x}\pm s$).

Groups	Onset time of muscle relaxant (s)	Recovery time of spontaneous breathing (s)	Physical Activity time (s)	Opening eyes time (s)
A group	124.28±39.18	412.07±115.03	565.04±185.02	630.29±159.21
V group	153.56±36.29	421.25±85.67	582.75±182.26	631.47±115.33
<i>t</i>	0.687	1.702	0.946	1.002
<i>p</i>	<0.05	>0.05	>0.05	>0.05

to the time for patients recovering autonomous breath), eye-opening time, and time of body movement¹¹. (3) The change in hemodynamics indexes, heart rate and mean arterial pressure (MAP) before and after intubation.

Statistical Analysis

The acquired data was processed with SPSS software (SPSS Inc. Chicago, IL, USA). The comparison of measurement data was conducted by *t*-test, while that of enumeration data by χ^2 test. $p<0.05$ means that the results have statistical significance.

Results

Muscle Relaxant Results

The effective time of muscle relaxant in group A was significantly faster than that in group V ($p<0.05$), while the time recovering autonomous breath and autonomous limb movement in group A were slightly lower than that in group V ($p>0.05$). The eye-opening time in both groups was almost the same without statistical significance ($p>0.05$) (Table II).

Muscle Relaxant Monitoring

After muscle relaxant injected for 50-70 min, the rate of positive EMG in both groups was up to 100%, while EMG amplitude in group A was significantly higher than that in group V ($p<0.05$). See Figure 1. The time of 0% TW in both groups showed no statistical difference ($p>0.05$). After muscle relaxant injection for 30 min, the rate of positive EMG and TW value in group A was significantly higher than those in group V ($p<0.05$) (Table III).

Change in HR and MAP Before and After Injection

MAP and HR of patients in both groups show no statistical difference before and after anesthesia ($p>0.05$) (Figure 2).

Adverse Reactions

Patients in both parties had no erubescence, rash, bronchial spasm, and other representations of histamine release. Moreover, patients had a good recovery of muscle strength and breath after anesthesia without hypoxemia.

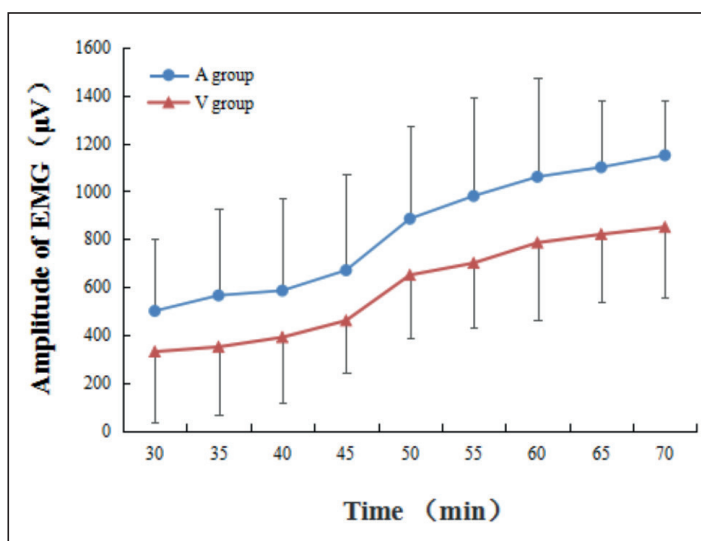


Figure 1. Amplitude of EMG from the time point of 30 to 70 min between two groups.

Table III. Muscle relaxation monitoring of patients in group A and group V.

Groups	No.	0% TW time (s)	30 min after injection of positive rate of EMG (%)	30 min after injection of TW value (%)
A group	60	264±35	100 ^a	16.1±4.5a
V group	60	259±33	85	9.3±3.1
<i>t/X²</i>		1.298	9.729	4.087
<i>p</i>		>0.05	<0.05	<0.05

Discussion

Intraoperative neuromonitoring (IONM) is always used to monitor the completeness of RLN and vagal function in thyroid surgery to avoid accidental injury of RLN at home and abroad. However, there are various mistaken IONM data in neural monitoring, which have limited the further application of this technology in clinical. Therefore, more accurate control over muscle relaxant dosage could make IONM more reliable^{12,13}. The

main source affecting EMG signal is muscle relaxant in clinical anesthesia¹⁴. Muscle relaxant can be classified into the conduction depressants for depolarized and non-depolarized neuromuscular. To obtain the ideal EMG signal, depolarizing muscle relaxants with shorter muscle relaxation effect is more suitable for IONM than other non-depolarizing muscle relaxants¹⁵⁻¹⁷. However, succinylcholine eliminates in organic body so quickly that limb movement and deglutition may occur in operation to affect the operating practice. Also, muscular

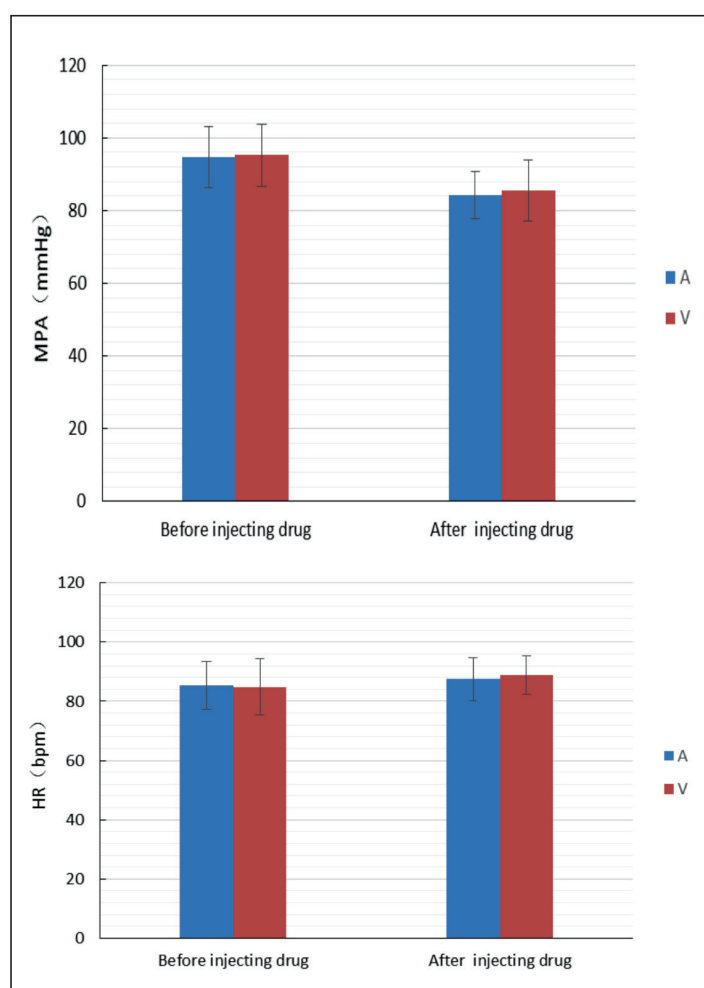


Figure 2. Hemodynamic changes of patients in two groups before and after anesthesia.

fibrillation caused by succinylcholine may result in muscle soreness of patients and even malignant hyperthermia and arrhythmia. Therefore, non-depolarizing muscular relaxant is more suitable in IONM than muscular relaxant¹⁸. Cisatracurium besylate is a non-depolarizing muscle relaxant with middle effects. This drug has weak effect on autonomic nervous system causing no histamine. Without adverse effects of cardiovascular disease, etc., histamine can be eliminated by Hofmann reaction in organic body. As the non-depolarizing muscular relaxant with middle effects in steroid, vecuronium bromide mainly competes for cholinergic receptor with acetylcholine to inhibit the action of acetylcholine. According to clinical experiences and product instruction, cisatracurium besylate and vecuronium bromide in double dosage or more, were selected in trachea intubation for this group to accelerate the effective time and obtain satisfied conditions for trachea intubation. The results of this study showed that 0% TW time of both groups was about 3 min, with no statistical difference ($p>0.05$). After muscle relaxant injection for 30 min, the rate of positive EMG and TW value in group A was significantly higher than those in group V ($p<0.05$). After muscle relaxant injection for 50-70 min, the rate of positive EMG of patients in both groups was up to 100%, and the EMG amplitude in group A was significantly higher than that in group V ($p<0.05$). This means that it requires a long time to reach 0% TW for patients in both group A and group V, which did not reach the requirements of "fast turnover of anesthesia and consecutive operation" in operating room. In the preliminary stage of thyroid surgery (30-40 min), EMG value with more clinical value could be detected in patients of group A. Moreover, during 30-70 min of intubation, average EMG amplitude in group A was significantly higher than that in group V. This could obviously reduce the false positive rate of IONM result and enhance the operation security in this period. Cisatracurium besylate has fast onset, strong action without accumulation, and fast recovery without liver dependency and histamine release. Moreover, it has weak effects on parasympathetic nerve, no significant effect on hemodynamics indexes, including blood pressure and HR, and does not increase the myocardial oxygen consumption¹⁹⁻²². With the equivalent dosage, the metabolite of cisatracurium besylate, N-tetrahydropapaverine hydrochloride is only 1/10 of atracurium. It avoids the symptoms of nervous centralis caused by accumulation of N-tetrahydropapaverine hydrochloride. This may be the

greatest advantage of cisatracurium besylate²³. The metabolism of vecuronium bromide is liver-dependent, so its clinical application is limited by liver functions²⁴. Recent results in this group show that MAP and HR of patients in both groups showed no statistical difference before and after injection, meaning that the influences of cisatracurium besylate and vecuronium bromide on hemodynamics were consistent. Also, the research results in this study showed that the time for muscle relaxation taking effects on patients in group A was significantly faster than that in group V ($p<0.05$), while the time of recovering autonomous breath and body movement in group A was slightly lower than that in group V ($p>0.05$). The eye-opening time in both groups was almost the same without statistical difference ($p>0.05$). This means that compared with vecuronium bromide, cisatracurium besylate has advantages of fast effective time and short duration, and was better than vecuronium bromide when creating conditions for trachea intubation and controlling drug effects²⁵⁻²⁷.

Conclusions

The average EMG amplitude and the positive rate of effective EMG amplitude of cisatracurium besylate were all higher than those of vecuronium bromide. With faster effects and shorter action time, cisatracurium besylate is more suitable in thyroid surgery IONM.

Conflict of Interest

The Authors declare that there are no conflicts of interest.

Ethics Committee Approval

The above cases were confirmed by the hospital Ethics Committee Approval and their families signed informed consent.

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