# The comparison of the incidence of postoperative Sore Throat, Hoarseness and Myalgia between rocuronium and succinylcholine for RSII: a randomized controlled trial

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Jie Wang
Zhongshan Hospital Fudan University

Fang Du
Zhongshan Hospital Fudan University

Jing Cang
Zhongshan Hospital Fudan University

Chao Liang
Zhongshan Hospital Fudan University

superwm226@aliyun.com*Corresponding Author*
*ORCiD: https://orcid.org/0000-0003-4754-8324*

Zhanggang Xue
Zhongshan Hospital Fudan University

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*Rocuronium, Succinylcholine, Sore Throat, Hoarseness, Myalgia*

## Abstract

**Background:** The present study was designed to compare the incidence of postoperative sore throat, hoarseness, and myalgia between rocuronium and succinylcholine for rapid sequence induction and intubation.

**Methods:** One hundred and twenty-four patients were randomly divided into rocuroniun group (group R, n=62) or succinylcholine group (group S, n=62). Anesthesia was induced with propofol 2mg kg-1 and remifentanil 2μg kg-1in both groups, and then rocuronium 0.6 mg kg-1 or succinylcholine 1.5mg kg-1 was given after patient lost consciousness. Tracheal intubation was performed 60s after these two muscle relaxants were given and the intubating conditions were evaluated. The incidences of postoperative sore throat, hoarseness and myalgia were evaluated at postoperative care unit(PACU), 12hours 24hours and 48hours postoperatively.

**Results**: The numbers of patients with excellent and good intubating conditions in group R were 90.0% and 6.7%, respectively, which were comparable with those in group S (91.7% and 5.0% respectively). The incidence of postoperative sore throat of group S (41.8%) was significantly higher than that of group R (18.3%) in PACU ($P<0.05$), at 12 hours (38% versus 10%, $P<0.05$) and 24 hours postoperatively (32% versus 6.7%, $P<0.05$), however, these differences reached an insignificant level at 48 hours postoperatively (3.3% versus 1.7%). There were some cases in both groups underwent hoarseness and/or myalgia at each time point, but the differences did not reach a significant level.

**Conclusions**: In the context of a RSII with lidocaine–remifentanil–propofol, compared with rocuronium, succinylcholine supplementation was associated with high incidence of postoperative sore throat.

**Trial registration:** The present study was prospectively registered at http://www.chictr.org/cn/(ChiCTR-IOR-15006977); Registration date: Nov 4, 2015

**Keywords:** Rocuronium, Succinylcholine, Sore Throat, Hoarseness, Myalgia

## Background

The sore throat and hoarseness are common postoperative throat complications of general anesthesia with tracheal intubation, with reported incidences of sore throat between 11 and 48% and those of

hoarseness between 18 and 53%[1, 2]. These side effects are undesirable postoperative outcome and negatively impact patient’s satisfaction and recovery[1, 3]. The possible reasons of postoperative throat complications are attributed to the mucosal erosion caused by the cuff of the tracheal tube[4], mucosal dehydration, and trauma from tracheal intubation[5].During the past decades, these complications have been greatly reduced by improved airway devices and modern anesthesia practices. However, it is unclear whether the type of induction agent used during anesthesia can affect the incidence of postoperative throat complications.

The administration of a fast-acting neuromuscular blocking agent (NMBA) is an important component of rapid sequence induction and intubation (RSII)[6]. Traditionally, given the quick onset along with the excellent intubation conditions, succinylcholine has been the commonest NMBA of choice for RSII. However, succinylcholine has serious side effects and is contraindicated in many situations [7]. Among the nondepolarizing muscle relaxants, rocuronium has become an alternative to succinylcholine which is associated with a rapid onset of action.

It has been reported that succinylcholine induction is associated with high incidence of postoperative sore throat[8, 9], especially when it is given by single injection. However, in these previous studies, the anesthesia induction is performed by thiopental, and supplied with fentanyl and muscle relaxant. Therefore, it is still unclear the influence of succinylcholine on the incidence of postoperative throat complications when it as a supplementation for modern short-acting agents, such as propofol and remifentanil. On the other hand, the incidence of postoperative throat complications of rocuronium has not been fully investigated. Furthermore, there are no systemic comparison of the incidence of postoperative throat between the rocuronium and succinylcholine at the comparable intubating conditions provided by these two agents. Therefore, it seems imperative to understand which one of them has a low incidence of postoperative throat complications, which might provide useful information on muscle relaxant selection in real clinical situation.

In present study, we hypothesized that during RSII with a lidocaine–remifentanil–propofol regimen, with the comparable intubating conditions provided by rocuronium and succinylcholine, there will be a low incidence of throat complications in patient using rocuronium. Therefore, we designed this

prospective and randomized study to verify this hypothesis in patients undergoing elective surgery.

## Methods

The present study was registered at http://www.chictr.org/cn/ (ChiCTR-IOR-15006977) and was approved (B2015-114R) by the Ethics Committee of Zhongshan Hospital, Fudan University, China. Between August 2015 and August 2017, we enrolled 124 consecutive patients, 25–65 years of age and ASA I–II, who were scheduled for elective surgery under general Anesthesia. Written informed consent was obtained from all patients before randomization. Exclusion criteria were a history of allergy to rocuronium, succinylcholine, propofol and remifentanil, gastro-esophageal reflux, a known predisposition to malignant hyperthermia, neuromuscular disease and medications that could influence neuromuscular function, body mass index more than 35 $kg/m^2$, anticipated difficult intubation, history of throat diseases, patients with a contraindication to the use of succinylcholine were also excluded.

Patients were randomly assigned into two groups by the program of SPSS16.0 software, the rocuronium group (Group R, n=62) and succinylcholine group (Group S, n=62). No preoperative sedatives or analgesics were administered. The monitoring of each patient included electrocardiogram, oxygen saturation, noninvasive blood pressure, capnography and BIS (BIS; A-2000TM SP, Aspect Medical System, Norwood, MA, USA). A train-of- four (TOF) mode was used to stimulate the ulnar nerve at the wrist. A brief period of initial TOF-Watch calibration was performed after informing the patient of the initiation of nerve stimulation. The output current was kept at 40-50 mA (delivered at 2 Hz every 12 s). In group R, the TOF counts at 60s after rocuronium injection and the time to loss of TOF were recorded. A 18G cannula was inserted into a vein in the forearm and lactated Ringer’s solution was started before induction of Anesthesia. Two three-way stopcocks were used in our study, one is connected with the syringe pump of remifentanil, and the another one was attached to the first one to allow for injection of other agents during induction. All patients received 100% oxygen for 3 min through an anesthesia facemask before any drugs injection. The pain on injection during rocuronium and propofol administration was graded by using a four-point scale (none, mild, moderate and severe). A Glidescope video laryngoscopy (blade

size 3) was used in all patients during tracheal intubation.

The positive pressure ventilation was not performed before the endotracheal tube was inserted. After preoxygenation, a bolus of 1 mg $kg^{-1}$ lidocaine was given, then anesthesia was induced with intravenous remifentanil 2μg $kg^{-1}$ given over 30s and propofol 2mg $kg^{-1}$ (administered within 5s). After loss of consciousness (judged by loss of eyelash reflex and response upon calling out the patient's name), the rocuronium (0.6 mg $kg^{-1}$, administered within 5s) and succinylcholine (1.5mg $kg^{-1}$, administered within 5s) was given in group R and group S, respectively. Tracheal intubation was performed 60s after rocuronium and succinylcholine injection. After intubation, anesthesia was maintained with 0.7-1.0 MAC of sevoflurane and remifentanil infusion and additional boluses of rocuronium 10mg and fentanyl 50μg were given if necessary. The patient's mean blood pressure (MAP) and heart rate (HR) were recorded before induction of anesthesia, immediately, 1min and 3min after tracheal intubation. To prevent the anesthesiologist who performed the tracheal intubation and evaluated the intubating conditions from noting the muscle fasciculations induced by succinylcholine, she was called to enter the operating room 50s after administration of the rocuronium or succinylcholine.

The intubating conditions of each patient was graded as excellent, good, or poor, which were depending on the guidelines for Good Clinical Research Practice in Pharmacodynamic Studies of Neuromuscular Blocking Agents[10](Table.1). Both excellent or good intubating conditions were regarded as clinically acceptable, and the poor intubating conditions were regard as clinically unacceptable.

All patients were interviewed at the time of entrance to the PACU and 2h, 12h, 24h, 48h postoperatively to assess postoperative sore throat, hoarseness and myalgia. As showed in Table.2, these complications were evaluated by the criteria reported by Thomas et al[11], any score ≥1was defined as sore throat or hoarseness or myalgia. The hemodynamic events (hypotension/ hypertension, tachycardia/ bradycardia) during the induction and intubation were also assessed.

**Statistical analysis**

The primary endpoint of our study was the incidence of sore throat in two groups. Given the reported incidence of sore throat is about 68%(24h after operation) in patient using bolus succinylcholine[8], we assumed that with the same intubating conditions, more than 15% difference (down to 53%) was of clinical significance. With a 0.05 level of significance and 80% power, it was calculated that 59 patients were required in each group. Therefore, we included 62 patients per group to compensate for dropouts. Statistical analyses were performed using SPSS16.0 (SPSS, Chicago, IL, USA). Patient characteristic data and continuous data were expressed as mean±(SD). Student's t test was used to analyze continuous data. Categorical data were expressed as percentages and numbers and were compared using Chi-square or Fisher's exact test. A P value of $<0.05$ was considered as statistically significant.

## Results

A total of 124 patients were assessed for eligibility, and all of them were randomized. Because of protocol violation (remifentanil infusion overdose), both group R and S had 2 patients were excluded. Demographic data and patient's characteristics are presented in Table.3. Endotracheal intubation was successful on the first attempt in all patients. The numbers of patients had excellent intubating conditions in group R and S were 54(90.0%) and 55(91.7%), respectively. (Figure.1) The numbers of patients had good intubating conditions in group R and S were 4(6.7%) and 3(5.0%), respectively(Figure.1), all the causes of which were attributed to the not fully relaxed jaw during intubation. Because of poor jaw relaxation, both group R and S had 2 patients with poor intubating conditions.

As show in Figure.2, the incidence of sore throat in group S was higher than that of group R in PACU (41.8% versus 18.3%, $p<0.05$), 12 hours postoperatively (38% versus 10%, $P<0.05$), 24 hours postoperatively (32% versus 6.7%, $P<0.05$), and was comparable at 48 hours postoperatively(3.3% versus 1.7%). The incidence of hoarseness were comparable in PACU (0% versus 3%), 12 hours postoperatively(1.6% versus 1.6%), 24 hours postoperatively(1.6% versus 1.6%), and 48 hours postoperatively(0% versus 0%) in group R and group S. Similarly, the incidence of myalgia in group R and group S in PACU(0% versus 0%), 12 hours postoperatively (0% versus 3.3%), 24 hours

postoperatively(0% versus 3.3%), and 48 hours postoperatively(0% versus 0%) were also comparable. Baseline values for MAP and HR were similar in both groups, the incidence of hypotension and bradycardia were comparable in group S(27% and 10%) and R(22% and 8.3%).

As show in Table.4, no hypertension or tachycardia was observed in two groups during the investigation period. The average BIS values at the time of intubation in group R and group S were 45.1±4.1 and 43.2±5.5, respectively. The TOF counts were recorded at the time of intubation in group R. There were 49 patients failed to produce an acceptable level of neuromuscular blockade at the adductor pollicis. Time to loss of TOF was 112.4±17.6s in group R. No patients in two groups complain of the pain on injection of rocuronium or propofol. No patients in either group experienced desaturation, laryngospasm, bronchospasm, or any other significant complications. At the PACU, 12h, 24h and 48h postoperatively visit, no patient describing memories or events suggestive of awareness during induction or intraoperatively.

## Discussion

We investigated the incidence of postoperative sore throat, hoarseness, and myalgia between rocuronium and succinylcholine for rapid sequence induction and intubation. Our study showed that, in the context of a RSII with lidocaine–remifentanil–propofol, under the comparable intubating conditions provided by two types of muscle relaxants, succinylcholine supplementation was associated with a high incidence of postoperative sore throat.

It has been reported that excellent intubating conditions provided by remifentanil 2μg $kg^{-1}$ in combination with propofol 2mg $kg^{-1}$ did not exceed 50%[12]. And only 60% of patients have excellent intubating conditions when the induction regimen using remifentanil 4μg $kg^{-1}$ combined with propofol 2.5mg $kg^{-1}$ [13]. However, with the increasing doses of remifentanil and propofol, homedynamic compromise such as bradycardia or hypotension could be a concern. On the other hand, the tracheal intubation attempted without neuromuscular blocking may increase the incidence of vocal cord sequelae. Consistently with those studies, in our pilot study, when RSII was induced by lidocaine(1mg $kg^{-1}$)–remifentanil(2μg $kg^{-1}$)–propofol(2mg $kg^{-1}$) regimen without any muscle relaxant supplement,

nearly all patients had a poor intubating conditions, which were mainly attributed to the poor jaw relaxation and/or a closed vocal cord and/or sustained coughing(data not show). Therefore, supplementing this induction regimen with a NMBA may improve the quality of tracheal intubation and decreases postoperative vocal cord sequelae[14]. Our results indicated that in the context of a RSII with lidocaine(1mg $kg^{-1}$)–remifentanil(2μg $kg^{-1}$)–propofol(2mg $kg^{-1}$), comparable intubating conditions were achieved 60s after rocuronium 0.6 mg $kg^{-1}$ or succinylcholine 1.5 mg $kg^{-1}$ administration.

Many factors, such as gastric tube insertion, type of surgery, head and neck positions, gender, and endotracheal tube size, are known to contribute to postoperative throat complications.[3, 15, 16]. In present study, no patient had a gastric tube, and no patient underwent ear-nose-and-throat surgery. In addition, the sex ratio and distribution of tube sizes did not differ between the two groups. Therefore, most of the known confounding factors were controlled. Our results showed that the incidence of postoperative sore throat was significantly higher in the group of patients receiving succinylcholine (41.8%) in PACU, 12 hours postoperatively (39%) and 24 hours postoperatively (32%). These results are comparable in trend to the results from Capan et al and Farhad et al[8, 9].In Capan’s study, at the 24hours postoperatively, sore throat was experienced in 68% of patients who had received bolus 1.0 mg/kg succinylcholine, and the incidence of the hoarseness and myalgia were 28% and 68%, respectively. Interestingly, for investigating the pure impact of succinylcholine on these complications, any ventilation equipment was avoided in their study. Similarly, the results from Farhad et al also showed a high incidence of sore throat (75%) in patients receiving succinylcholine at the time of entrance to the PACU. The differences of the incidence of postoperative throat complications and myalgia between these studies and ours may attributed to the fact that the evaluations were performed at different times. Another important reason is the different criteria used for complication evaluation, a simple criteria of “yes” or “no” was used to define the existence of throat complications and myalgia in these previous studies, while a criteria of “0-4 score scale” was used in our study (only the score ≥1 was regard as “yes”). Our results showed that the difference

between the incidence of sore throat caused by succinylcholine and rocuronium reduced as time went by, reaching an insignificant level at 48 hours postoperatively.

There is one study compared the influence of succinylcholine and rocuronium on the incidence of throat complications under different intubating conditions[11]. In this study, the rate of excellent intubating conditions was more frequent in the succinylcholine group(57%) compared with the rocuronium group(21%). Similar results were noted for clinically acceptable (excellent and good) intubating conditions: 89% versus 59%. These intubating conditions were achieved by using fentanyl-thiopental regimen and the tracheal intubation was performed 50s seconds after rocuronium or succinylcholine administration. And their results showed that the incidence of postoperative sore throat, hoarseness and myalgia between the succinylcholine and the rocuronium groups did not differ significantly. On the other hand, we used lidocaine–remifentanil–propofol regimen supplied by succinylcho- line or rocuronium, and the tracheal intubation was performed 60s after each of muscle relaxant. These differences between their study and ours may explain the results difference. For the underlying mechanism of the high incidence of throat complications and myalgia in patients receiving succinylcholine, the fasciculation induced by succinylcholine may the most possible causes. However, the results from both of the former [9] and our study showed that patients with or without fasciculation had almost equal chances of developing these complications and the incidence varied only based on the type of muscle relaxant used.

During the induction, the optimal intubating conditions are related more closely to the relaxation of the laryngeal adductors, diaphragm, and masseter etc, and the onset of neuromuscular block is more rapid in these muscles than in the adductor pollicis muscles[17]. This may explain why most patients in rocuronium group with excellent intubating conditions have a 4/4 of TOF count at the time of intubation. Therefore, the TOF monitoring at the adductor pollicis should not be considered as a useful endpoint defining optimal intubating conditions[18]. These results may reassure the opinion that “cadaveric” paralysis[19]is unnecessary for safe tracheal intubation under many situations. The Glidescope video laryngoscopy was used for intubation in the present study, since it is associated with improved intubating conditions, particularly in patients with potential or simulated difficult

airways [20].All patients were successful intubated at the first attempt in two groups. However, it seems that the intubating conditions or perioperative side effects in the previous studies are evaluated in the context of using the direct laryngoscopy for intubation. So the results from the present studies may provide some new insights to RSII practice.

In conclusion, in the context of a RSII with lidocaine–remifentanil–propofol and using the Glidescope video laryngoscopy, we demonstrated that rocuronium at the dose of 0.6 mg $kg^{-1}$ can provide comparable intubating conditions to succinylcholine 1.5 mg $kg^{-1}$. More importantly, compared with rocuronium, succinylcholine supplementation was associated with high incidence of postoperative sore throat. The results from present studies may providing some insights to decide which one is a more suitable option for induction and to guide physicians' choices of induction agent.

## Abbreviations

Group R:rocuronium group; Group S:succinylcholine group; ASA: American Society of Anesthesiologists;SD: standard deviation;PACU: postoperative care unit;NMBA: neuromuscular blocking agent; RSII:rapid sequence induction and intubation; BIS: Bispectralindex; TOF: train-of-four; MAP:mean blood pressure; HR: heart rate

## Declarations

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**Availability of data and materials**

Reasonable requests for access to the datasets used and/or analysed during this study can be made to the corresponding author

**Authors’ contributions**

JW and CL conceived and designed the study, collecting and interpretation of data, and drafting the manuscript. FD carried out the statistical analysis, and was involved in interpretation of data and drafting the manuscript. CJ and ZG X was involved in designing the study, and was involved in

interpretation of data and drafting the manuscript. All of the authors critically revised and approved the final form of the manuscript.

**Ethics approval and consent to participate**

This study was approved (B2015-114R) by the Ethics Committee of Zhongshan Hospital, Fudan University on Nov 4, 2015. All of the participants gave their written, informed consent to participate in the study.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

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## Tables

Tables are provided in the Supplementary Files section.

## Figures

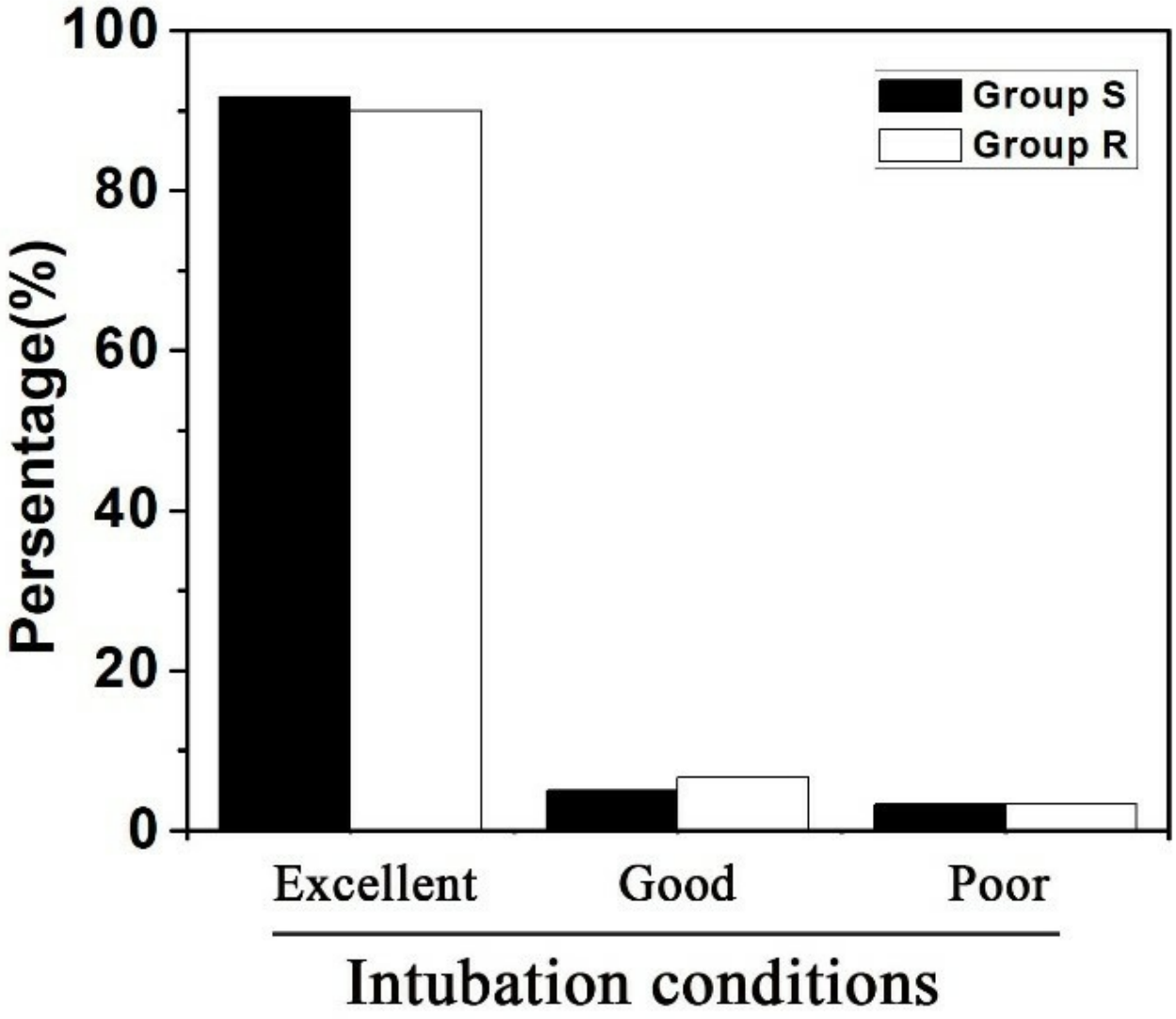
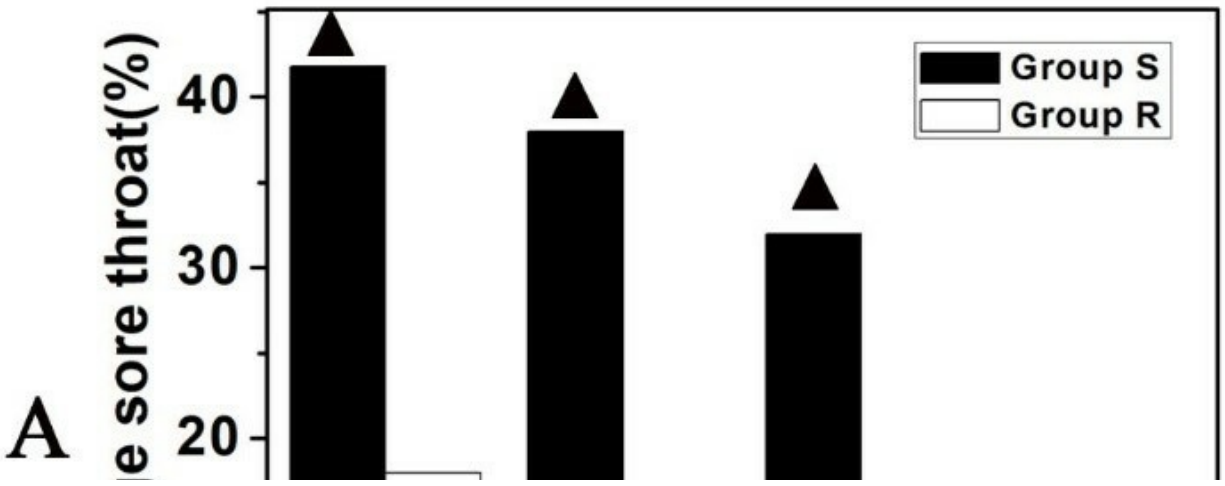
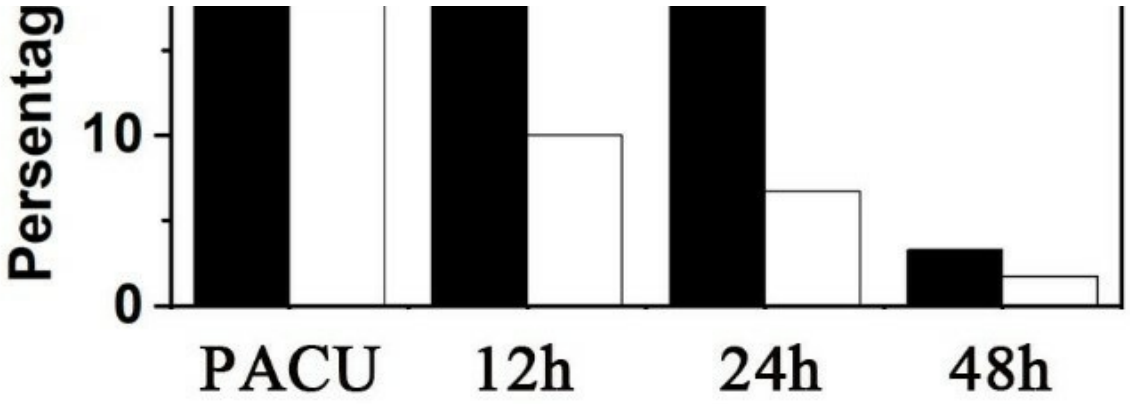



Figure 1

The percentage of different intubating conditions in patients receiving rocuronium or succinylcholine.

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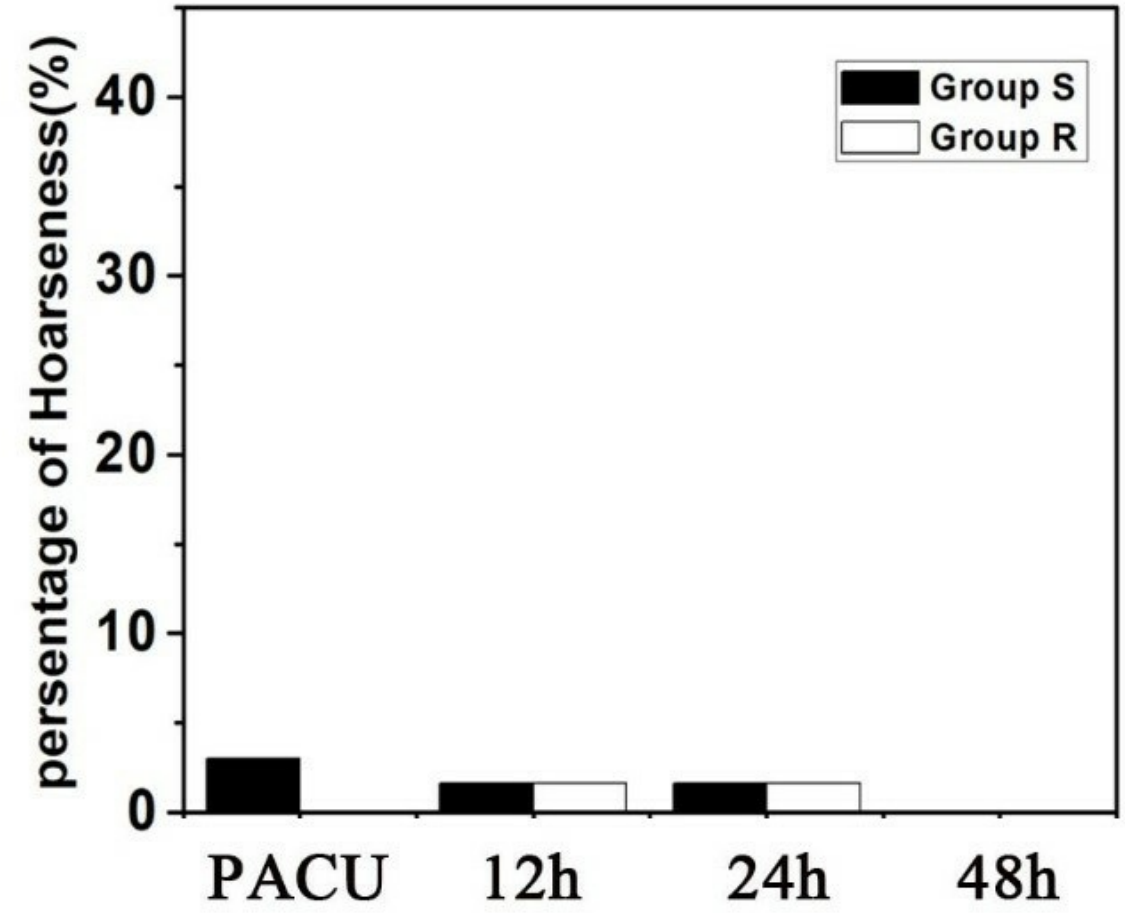
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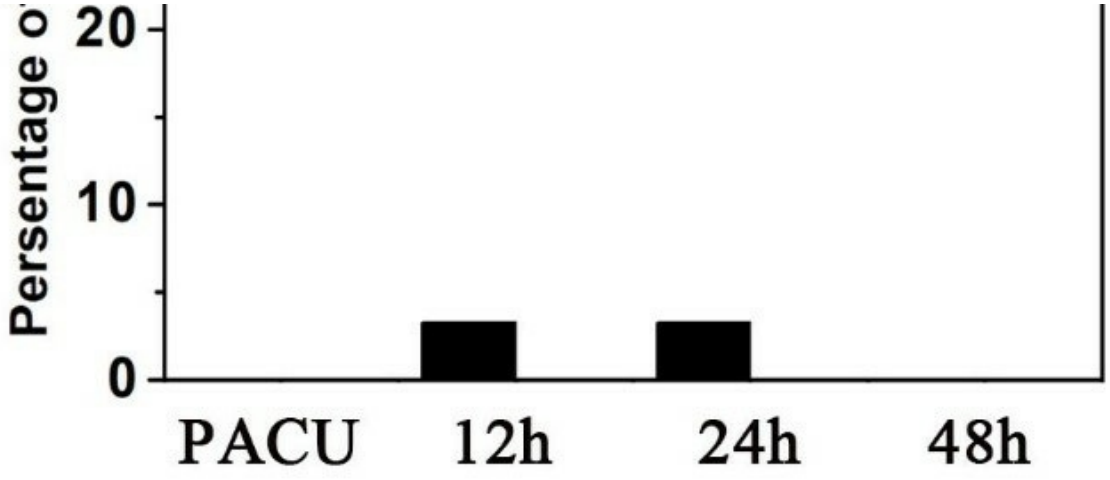


Figure 2

The incidence of postoperative sore throat, hoarseness and myalgia in patients receiving rocuronium or succinylcholine at different time point. ▲P <0.05 vs Group R.

## Supplementary Files

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