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· Original Article ·

Efficiency of Magnesium Sulfate versus Succinylcholine in Rapid Sequence Intubation

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Abstract

Background: Rapid sequence intubation (RSI) is an advanced airway management medical procedure used to achieve tracheal intubation under general anesthesia in patients who are at high risk of pulmonary aspiration. Succinylcholine is a common medication used during RSI with paralytic aim. On the other hand, Magnesium sulfate also has muscular relaxant effect. The aim of this study is the efficiency of magnesium sulfate instead of succinylcholine in RSI process will be studied.

Methods: This single blind clinical trial contained 90 patients divided into 2 equal groups. Group 1 received succinylcholine based on usual process of RSI and Group 2 received magnesium sulfate at preoxygenation step of RSI without succinylcholine injection. Heart rate, systolic and diastolic blood pressure for each patient had been measured at 6 different times. Obtained results were analyzed by SPSS ver. 22.

Results: The results showed significant reduction of the heart rate in all patients ($P < 0.05$). The heart rate of both groups at corresponding time were also compared and it had significant differences in most of critical times. These results also repeated for systolic and diastolic blood pressure. The excellent acceptability and quality of intubation in group 1 was higher rather than group 2, but statistical analysis did not show any significant differences between them ($P > 0.05$).

Conclusion: Based on the obtained results in this study, it can be concluded that using succinylcholine or magnesium sulfate in RSI process has same effect on intubation outcome.

Key words Rapid sequence intubation; Succinylcholine; Magnesium sulfate; Heart rate; Blood pressure

Introduction

Rapid sequence intubation (RSI) is a common airway management technique in emergency medicine to keep trachea open in patients with a full stomach, or at high risk of pulmonary aspiration of gastric contents by considering the patient hypoxia prevention between induction and intubation, minimizing the time between administering rapid-onset hypnotic and neuromuscular-blocking drugs that induce prompt unconsciousness and paralysis, and insertion of an endotracheal tube and at last, managing the situation to lower the risk of gastric aspiration[1].

During inducing paralysis or induction step, two main types of medications are commonly co-prescribed: sedations such as Ketamine, Propofol, Thiopentone, and Etomidate, and paralytics involving depolarizing drugs like Succinylcholine and also non-depolarizing agents such as Rocuronium[2], which Succinylcholine is the most common paralytic of this list[3]. Succinylcholine is composed of two Acetylcholine molecules bonding to each other through their acetyl groups. Attaching permanently to Acetylcholine receptor, this medicine causes depolarization and paralysis[4]. In case of medications allergy, it could cause malignant hyperthermia, denervation syndrome and it also has 24-48 hours contraindication after burns or accidents[5]. Moreover, its side effects, for instance muscle pains, acute rhabdomyolysis with high blood levels of potassium especially in patients with renal failure, transient ocular hypertension, jaw spasm and constipation are widely reported[6]. Another acute side effect is agonistic effect on cardiovascular and ganglions safety leading to bradycardia and temporary cardiac arrest. Following these problems, it also could lower systolic and diastolic pressure[7]. According to these wide range of side effects which some of them are also life threatening, finding RIS methods which do not use NMBAs such as Succinylcholine is really noteworthy these days[8].

Magnesium, as a forth important cation in human body, plays special role in many physiological mechanisms of the body[9]. Among these functions, blocking the N-Methyl-D-Aspartate (NMDA) receptor and also calcium channels, have special place in anesthesia science[9]. Magnesium

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sulfate is one of the oldest medications which is used in preeclampsia, asthma, and heart arrhythmias[10]. Due to analgesics and muscle relaxants effects, this component was used as a postoperative pain killer in both infusion and single dose bolus mode for years[10-13]. Magnesium causes muscle relaxants by binding to the end plate of presynaptic neurons and blocks the channels which inhibit acetylcholine release[14]. Magnesium sulfate had been used to relieve the cardiovascular symptoms of intubation[15,16].

According to the mentioned items, complication and prohibition cases of succinylcholine, the efficiency of magnesium sulfate instead of succinylcholine in RSI process will be studied.

Materials and methods

This single blind clinical trial has been conducted at Alzahra and Ayatollah Kashani Hospitals at 2015 and concluded 90 patients based on the comparison of two means formula. Patients were divided into 2 equal groups by randomized block method. The first group (Group 1) received succinylcholine based on usual process of RSI and the second group (Group 2) received magnesium sulfate at preoxygenation step of RSI without succinylcholine injection.

The intubation ease was measured based on Copenhagen score which is evaluated by laryngoscopy ease, position and movement of vocal cords, and patients' response (cough and diaphragm movement). The laryngoscopy ease classified into easy, fair, and difficult groups which is described in Table 1.

The intubation ease was classified into excellent (excellent result for all indexes), good (excellent or good result for all indexes), and poor (under poor result for even one of the indexes). The poor results were clinically unacceptable. Intravenous injection of succinylcholine (1.5 mg/kg) was used in unacceptable cases. Intubation failure defined after 3 failed attempts.

Heart rate and blood pressure were measured using non-invasive methods in 6 steps (Table 2).

The used preventive measures in adverse condition of patients 5 min after RSI can be seen in supplementary table (Sup. 1).

The statistical analysis of obtained data was conducted by SPSS ver. 22.

Results

Ninety patients have been participated in this study and divided into 2 groups (45 patients in each groups). Due to statistical analysis, both groups were similar in sex and age ($P > 0.05$). The results of this study will be reported in 4 categories.

Heart rate changes

The heart changes of patients were investigated in both groups and analyzed by non-parametric Friedman test. The mean heart rates of Group 1 were 92.09, 80.67, 86.49, 82.00, 77.91, and 78.31 in each critical times (T1-T6), respectively. These results were 84.27, 72.93, 74.04, 70.24, 64.20, and 75.84 for Group 2. The results showed significant reduction of the heart rate in all patients ($P < 0.05$).

The heart rate of both groups at corresponding time were also compared by *Mann-Whitney* U test. The results showed similar heart rate in T1 and T6 (P were 0.053 and 0.544, respectively) in two groups and it had significant differences in other critical times ($P < 0.05$).

Systolic blood pressure

The systolic blood pressure of patients were investigated in both groups and analyzed by non-parametric Friedman test (Table 3). Statistical analysis showed significant changes of this parameter in various times ($P < 0.05$). The systolic blood pressure of both groups at corresponding time were also compared by *Mann-Whitney* U test. The results showed similarity in T1 and T2 (P were 0.912 and 0.398, respectively) in two groups and it had significant differences in other critical times ($P < 0.05$).

Diastolic blood pressure

The diastolic blood pressure of patients were investigated in both groups and analyzed by non-parametric Friedman test (Figure 1). Statistical analysis showed significant changes of this parameter in various times ($P < 0.05$). The diastolic blood pressure of both groups at corresponding time were also compared by *Mann-Whitney* U test. The results showed similarity in T1 ($P = 0.820$) in two groups and it had significant differences in other critical times ($P < 0.05$).

Quality and acceptability of intubation

The quality and acceptability of intubation were evaluated in this study (Table 4). Although the excellent acceptability and quality of intubation in group 1 was higher rather than group 2, but the results of non-parametric Fisher's exact test did not show any significant differences between them ($P > 0.05$).

Discussion

Rapid sequence intubation is an advanced airway management medical procedure used to achieve tracheal intubation under general anesthesia in patients who are at high risk of pulmonary aspiration[17]. The induction drugs

Table 1 Laryngoscopy ease classification

Laryngoscopy ease groups	Definition
Easy	Jaws′ relaxation and the lack of resistance to the laryngoscope blade
Fair	Partial relaxation of the jaw and brief resistance to the laryngoscope blade
Difficult	Lack of jaws′ relaxation and resistance against laryngoscope blade

Table 2 Critical times for heart rate and blood pressure measurement

Times	Definition
T1	Before rapid sequence intubation
T2	After magnesium sulfate infusion or succinylcholine injection
T3	After intubation
T4	5 min after intubation
T5	10 min after intubation
T6	15 min after intubation

Sup. 1 Preventive measures in adverse condition 5 min after RSI

Adverse condition	Medicine	Dosage
Systolic blood pressure≥150 mmHg	Nicardipine	0.5-1 mg
Heart rate≥110	Nicardipine	0.5-1 mg
Systolic blood pressure≤80 mmHg	Ephedrine or Atropine	5-10 mg
Heart rate≤50	Ephedrine or Atropine	0.5 mg
Respiratory complications such as apnea	Calcium gluconate	10 mL

Table 3 Statistical analysis of the systolic blood pressure

Systolic blood pressure (Sys BP), mmHg	Group 1: Succinylcholine					Group 2: Magnesium sulfate				
	Mean	SD	Min	Max	Mean rank	Mean	SD	Min	Max	Mean rank
Sys BP before induction	117.73	9.461	100	140	4.18	117.78	10.088	100	150	5.31
Sys BP after induction	107.13	8.971	90	125	2.04	109.11	10.460	90	130	3.18
Sys BP after intubation	128.80	12.387	100	165	5.66	116.89	11.346	95	140	5.13
Sys BP 5 min after intubation	119.56	13.041	90	160	4.06	111.56	11.472	85	135	3.77
Sys BP 10 min after intubation	107.76	13.848	75	140	2.28	102.33	9.330	80	125	1.83
Sys BP 15 min after intubation	110.69	12.440	80	130	2.79	100.89	9.670	80	130	1.78
Chi-Square			130.429					165.041		
df			5					5		
P			0.000					0.000		

Table 4 Quality and acceptability of intubation in both groups

Variables	States	Drug groups		Total	df	*P*
		Group 1	Group 2			
Intubation quality	Excellent	33	25	58	2	0.249
	Good	9	14	23		
	Poor	3	6	9		
Intubation acceptability	Acceptable	42	39	81	1	0.485
	Unacceptable	3	6	9		

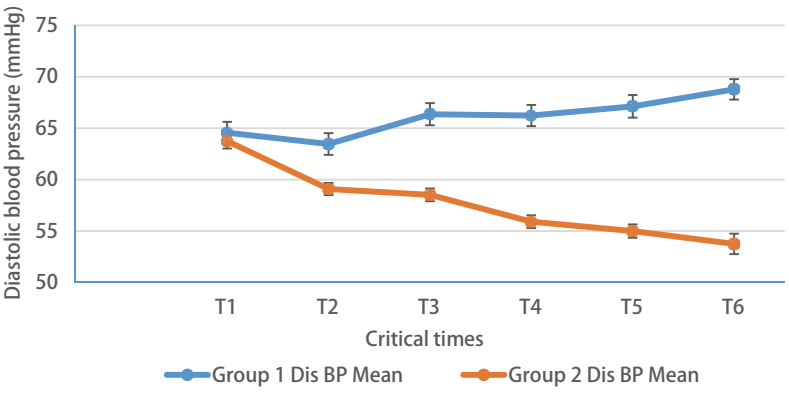

Figure 1 Statistical analysis of the diastolic blood pressure (Dis BP)

traditionally used for RSI have short durations of action, wearing off after only minutes. This confers a degree of fault tolerance on the procedure when it is used in elective or semi-elective settings: if intubation is unsuccessful, and if the clinical condition allows it, the procedure may be abandoned and the patient should regain the ability to protect their own airway sooner than would be the case under routine methods of induction. Conversely, in emergency settings where the patient's condition does not allow for them to be woken up immediately, a failed intubation under RSI places them at very high risk for respiratory compromise. Succinylcholine, Rocuronium, and Vecuronium are common medications are use during RSI with paralytic aim[18-20]. On the other hand, Magnesium sulfate also has muscular relaxant effect[21,22]. Based on these information, the efficacy and adverse effects of magnesium sulfate versus succinylcholine in rapid sequence intubation were evaluated in this study.

Our results illustrated that magnesium sulfate reduce the heart rate, systolic and also diastolic blood pressure in comparison to succinylcholine. Although the excellent acceptability quality of intubation with succinylcholine was higher rather than magnesium sulfate, but there were not any statistical significant differences between them.

It has been showed that simultaneous use of Magnesium sulfate and Rocuronium provide better condition for RSI[23]. On the other hand, it has been shown that Magnesium, as a prodrug, can reduce the fasciculation and hyperkalaemia rate caused by succinylcholine without any significant effect on malignant hyperthermia[24-26]. In a study on 60 patients, the intubation had been conducted without NMBA. The results of this study showed significant positive effect of magnesium sulfate infusion in intubation process[27]. Our results also indicated the same effect of magnesium sulfate during RSI.

Park *et al.*[28] investigated the effect of magnesium sulfate pretreatment in RSI. Their study conducted 154 patients whom received 50 mg/kg of magnesium sulfate. Same to our results, their ones showed positive effect of this compound on RSI. They concluded that $MgSO_4$ administration prior to RSI using alfentanil, propofol, and rocuronium may improve intubating conditions and prevent post-intubation hypertension.

El-kobbia *et al.*[29] published the results of their study on 2015 which was a comparative study between succinylcholine, rocuronium and magnesium sulfate with rocuronium in RSI. Their results showed the shorter onset time in the succinylcholine and magnesium groups. The intubating conditions were significantly better in the magnesium group ($P < 0.001$) compared with the other two groups. They also showed significant increases in heart rate and blood pressure were observed at 1 min after intubation in the succinylcholine and rocuronium groups relative to stable haemodynamics in the magnesium group ($P < 0.05$). It is notable that these results are same to ours.

Sakuraba *et al.*[30] showed that pretreatment with magnesium is more effective to limit succinylcholine-induced fasciculation and subsequent tracheal intubation-induced hemodynamic changes in rapid sequence induction compared with vecuronium pretreatment, although magnesium does not prevent the elevation of serum potassium concentration after induction.

Conclusion

Based on the obtained results in this study, it can be concluded that using succinylcholine or magnesium sulfate in RSI process has same effect on intubation outcome.

Conflict of interest

The authors have no conflict of interest.

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