Effects of Magnesium Chloride on Rocuronium-induced Neuromuscular Blockade and Sugammadex Reversal in the Isolated Rat Phrenic Nerve-hemidiaphragm Preparation

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Background

Magnesium potentiates the effect of nondepolarizing muscle relaxants. However, studies which have been conducted by using magnesium chloride (MgCl₂) are rare. Sugammadex reverses neuromuscular block by steroidal nondepolarizing muscle relaxants. The purpose of this study is to investigate effects of MgCl₂ on rocuronium-induced neuromuscular blockade and its reversal by sugammadex.

Materials and Methods

Left phrenic nerve-hemidiaphragms from 40 Sprague-Dawley rats were randomly allocated to four groups (1 mM, 2 mM, 3 mM and 4 mM MgCl₂ group, each n =10). Rocuronium was administered cumulatively until the first twitch (T1) of train-of-four (TOF) completely disappeared for obtaining the effective concentration (EC) of rocuronium in each group. Thereafter, equimolar sugammadex was administered and recovery of T1 height and TOF ratio were measured for 30minutes.

Results

Table 1. Comparisons of effective concentration of rocuronium

	Concentration of MgCl ₂			
	1 mM	2 mM	3 mM	4 mM
EC ₅ (μg/ml)	3.7 ± 1.0	3.2 ± 0.6	2.4 ± 0.6*	2.3 ± 0.3*, †
EC ₅₀ (μg/ml)	7.8 ± 1.1†	5.9 ± 0.6*	4.5 ± 0.8*, †	4.3 ± 0.4*, †
EC ₉₀ (μg/ml)	11.4 ± 1.3†	8.4 ± 0.5*	6.5 ± 1.2*, †	6.2 ± 0.7*, †
EC ₉₅ (μg/ml)	12.1 ± 1.3†	9.0 ± 0.5*	7.0 ± 1.2*, †	6.7 ± 0.7*, †

Fig. 1. The concentration – response curves of rocuronium

Table 2. Recovery data after sugammadex administration

	Concentration of MgCl ₂			
	1 mM	2 mM	3 mM	4 mM
Dur 25% (sec)	260.3 ± 92.1	241.8 ± 110.6	303.3 ± 118.7	411.1 ± 174.0†
Dur 25-75% (sec)	328.0 ± 162.5	364.6 ± 123.0	362.1 ± 162.7	554.6 ± 301.8
Dur 95% (sec)	741.1 ± 340.1	567.5 ± 68.6	738.3 ± 146.8	1083.0 ± 215.4
DurMax T1 (sec)	1039.0 ± 351.8	926.0 ± 278.1	1211.0 ± 392.0	1483.9 ± 237.0* †
DurTOFR 0.9 (sec)	1177.1 ± 432.7	997.5 ± 376.1	1101.6 ± 381.6	1146.0 ± 228.5
Maximal T1 (%)	96.4 ± 14.3	87.2 ± 7.0	88.9 ± 23.5	87.3 ± 14.2
Maximal TOFR (%)	98.7 ± 8.9	98.4 ± 3.4	94.7 ± 6.9	89.6 ± 8.7*
Maximal TOFR < 0.9 (n)	1	0	3	5

Dur 25%: time from reversal to recovery of T1 to 25%, Dur 25-75%: time to recovery of T1 from 25 to 75%, Dur 95%: time from reversal to recovery of T1 to 95%, DurMax T1: time from reversal to the first of maximal T1 height, DurTOFR 0.9 : time from reversal to TOFR of 0.9. *: P < 0.05, vs. 1mM MgCl₂, †: P < 0.05, vs. 2mM MgCl₂.

Conclusion

The increase of MgCl₂ concentration reduces the ECs of rocuronium. In addition, equimolar sugammadex for administred rocuronium shows the limited efficacy as the change of MgCl₂ concentration