两种肌松药在小儿气道异物取出术中的疗效分析

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摘 要：【目的】观察罗库溴铵与琥珀胆碱在小儿气道异物取出术中维持肌松的临床效果、术中术后并发症的发生及术后拔管、肌力恢复情况。【方法】选择我院2013年1月至2016年1月80例择期行气道异物取出术患儿，其中30例为年龄大于3岁患儿，根据麻醉诱导时静注的肌松药随机分为2组（$n = 40$）：罗库溴铵组（R组）0.9 mg/kg，琥珀胆碱组（S组）1.5 mg/kg；术中根据肌松程度及手术时间，R组必要时追加静注罗库溴铵0.3 mg/kg，S组必要时追加静注琥珀胆碱0.5 mg/kg，其余用药一致。观察项目包括：支气管镜置入条件比较，术中肌松程度，追加静注肌松药和阿托品的次数，气管插管拔除时间，术中术后生命征、血流动力学动态观察及并发症的发生情况，年龄大于3岁患儿术后24 h肌肉酸痛发生率。【结果】①两组患儿支气管镜置入条件比较差异无统计学意义（$P > 0.05$）。②两组术中肌松程度无明显差别，但R组患儿均无需追加肌松药及阿托品，而S组所有患儿均需追加肌松药和阿托品，两组间比较差异有统计学意义（$P < 0.01$）。③术中术后生命征、血流动力学动态观察平稳，两组间比较差异无统计学意义（$P > 0.05$）；S组患儿有出现体动、低氧血症、苏醒期躁动等并发症，而R组仅出现喉痉挛及苏醒期躁动各1例，两组间比较差异有统计学意义（$P < 0.05$）。④术后15 min S组患儿肌力恢复比R组明显，肌力恢复程度与R组比较差异有统计学意义（$P < 0.01$）。⑤手术结束后气管插管拔除时间R组患儿比S组延长，差异有统计学意义（$P < 0.05$）。⑥术后24 h随访30例年龄大于3岁患儿，S组（14例）患儿表现为躯干及四肢肌肉酸痛；R组（16例）患儿均无全身肌肉酸痛发生，两组比较差异有显著统计学意义（$P < 0.01$）。【结论】小儿气道异物取出术中应用罗库溴铵与琥珀胆碱均有较好肌松效果，前者肌松效果更佳，安全性更好，可提供更好的手术条件和持续平衡的麻醉深度，术后24 h无肌肉酸痛，后者术中大多须继续追加药物，且术中、术后易出现并发症，术后24 h出现肌肉酸痛。

关键词：罗库溴铵；琥珀胆碱；全身麻醉；气道异物；支气管镜检查术
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Therapeutic Analysis of Two Kinds of Muscular Relaxation in Airway Foreign Body Removal Operation in Children

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Abstract:【Objective】To observe the muscle relaxation clinical effect and the occurrence of intraoperative and postoperative complications, and the postoperative extubation and muscle strength recovery of Rocuronium and Succinylcholine in children during airway foreign body removal operation.【Methods】80 cases of children (ASA Ⅰ) with airway foreign body, among them, 30 cases were older than 3 years old, were agreed to be on electively airway foreign body removal surgery. According to anesthesia induction, intravenous injection muscle relaxants were randomly divided into two groups ($n = 40$): Rocuronium group (Group R) 0.9 mg/kg, Succinylcholine group (Group S) 1.5 mg/kg. According to the degree of muscle relaxation and operation time, if necessary, patients in Group R were added intravenous injection with Rocuronium 0.3 mg/kg, patients in Group S were added intravenous injection with Succinylcholine 0.5 mg/kg, the other drugs were consistent. Observation items included: the bronchoscopy conditions, the degree of muscle relaxation during operation, the numbers of intravenous injection muscle relaxant and atropine, the times of tracheal extu-

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bation, the dynamic observation about vital sign and hemodynamic intraoperative and postoperative, and the occurrence situation of complications, the incidence rate of muscle soreness in children older than 3 years old 24 h after operation.【Results】(1)There was no significant statistics difference between the two groups in the condition of bronchoscopy ($P > 0.05$). (2)The patients in Group R were not required to add muscle relaxants and atropine, but all patients in Group S were required to add muscle relaxants and atropine ($P < 0.01$). (3) The complications such as body movement, hypoxemia, restlessness during recovery period were happened in Group S, and in Group R, there were only 1 case of laryngeal spasm and restlessness during recovery period, there was statistically significant difference between the two groups ($P < 0.05$). (4)The muscle strength recovery of 15 min in Group S was significantly higher than the Group R ($P < 0.01$).(5)The time of tracheal cannula extubation was extended after the operation in Group R, there was statistically significant difference between the two groups ($P < 0.05$).(6)30 cases patients older than 3 years old were followed up 24 h after operation, 14 cases in Group S were found with the muscle soreness of trunk and limb, but none was found in 16 cases in Group R, there was statistically significant difference between the two groups ($P < 0.01$).【Conclusions】The muscle relaxant effect was well during the removal of foreign body in children with Rocuronium and Succinylcholine, but the former provided a more security anesthesia condition, the muscle soreness of trunk and limb was not found in patient 24 h after operation; and the latter must continue to add drugs in operation, and the complications were found during and after the operation, the muscle soreness of trunk and limb was found in patient 24 h after operation .

Key words: Rocuronium; Succinylcholine; general anesthesia; airway foreign body; bronchoscope operation

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小儿气道异物取出术是耳鼻咽喉头颈外科一种风险极高的手术,如何保证术中患儿绝对安静且气道通气良好,对手术者和麻醉者是个极大的考验,也是手术顺利进行的关键,需要两者密切配合。随着手术、麻醉技术的进步和麻醉药品的研发及新药的应用,目前此类手术均采用全身麻醉。但由于手术时间较短、共用同一气道等特点,在手术中是否保留自主呼吸以及对肌松药类型的选择仍然存在争议[1-2]。本研究是笔者与麻醉科医师长期合作采用经全麻高频喷射通气的基础上,通过多年临床分析,观察比较罗库溴铵和琥珀胆碱两种肌松药在支气管镜检气道异物取出术中肌松效果、对于手术操作难易程度的影响及气道管理、术后拔管、患儿肌力恢复情况。现报道如下。

1 材料与方法

1.1 临床资料

选择我院2013年1月至2016年1月住院经影像学等检查证实气道异物并择期行支气管镜检气道异物取出术的病例80例,男46例,女34例,年龄1~5岁,平均(3.4±0.5)岁,体质量11~18 kg,平均(16.2±4.1)kg,其中30例为年龄大于3岁病例,美国麻醉师协会分级(ASA)为Ⅰ级;异物种类包括花生、黄豆和瓜子、蚕豆、塑料笔帽、牙齿等。入选标准:具有明确异物误吸病史,伴阵发性咳嗽,异物在左、右支气管,病史超过2天且无呼吸困难的择期性手术患者;排除标准:异物在主气管且病史< 24 h,术前有Ⅱ度以上吸入性呼吸困难须急诊手术的非择期性手术或接受二次手术的。本研究经医院伦理委员会同意、患儿家属签署知情同意书,将患儿按随机数字表法均分为两组:罗库溴铵组(R组)40例和琥珀胆碱组(S组)40例。全部患儿术前心电图(ECG)、血常规及凝血功能均正常。

1.2 治疗方法

麻醉前用药均为阿托品0.01 mg/kg肌注。开放上肢静脉通路,基础麻醉入睡后,常规ECG、连续监测无创血压(NIBP)及血氧饱和度(SpO_2)、呼气末二氧化碳分压($P_{ET}CO_2$)监测;麻醉诱导依次静注舒芬太尼0.4 μg/kg、丙泊酚2 mg/kg,随后分别静注以下肌松药:R组静注罗库溴铵0.9 mg/kg,S组静注琥珀胆碱1.5 mg/kg;并分别于注药后1~2 min进行支气管镜置入,接高频喷射通气(频率110次/min)经支气管镜侧孔间断予以控制呼吸及吸氧,维持SpO_2于95%~99%。持续输注丙泊酚5~6 $mg\cdot kg^{-1}\cdot h^{-1}$维持麻醉。根据肌松程度,必要时S组追加静注琥珀胆碱0.5 mg/kg、R组追加静注罗库溴铵0.3 mg/kg。若心率< 50次/min以及追加静注琥珀胆碱前均静注阿托品0.01 mg/kg。手术结束前5 min停止输注丙泊酚同时静注地塞米松0.2 mg/kg。支

气管镜退出后迅速经口气管插管辅助呼吸至完全清醒后予拔管。肌松程度监测由麻醉者采用加速度肌松监测仪（TOF-Watch SX，荷兰 Oganon 公司），采用4个成串刺激（TOF）方式刺激腕部尺神经，电流60 mA，肌颤搐维持在0～10%进行监测。

1.3　监测项目

术者根据插管评分表对支气管镜置入时的条件进行评分：三项指标评分均为3分者为优，有一项指标评分为2分者为良，有一项指标评分为1分者为差（表1）[3]。分别监测两组患儿术中术后生命征及血流动力学变化。统计两组患儿术中根据肌松程度需要追加静注肌松药及阿托品的次数。分别于小儿支气管镜置入时、手术结束行气管插管时、术后15 min和术后30 min测定肌松程度及监测术后气管插管辅助呼吸至完全清醒拔除时间。统计并分析两组术中术后并发症的发生情况。术后24 h随访30例年龄大于3岁患儿肌肉酸痛发生率。

1.4　统计学分析

采用SPSS 16.0统计软件进行处理。计量资料以$\bar{x} \pm s$表示，组间资料采用t检验分析。计数资料以%表示，组间采用卡方检验分析。取检验水平$\alpha = 0.05$。

2　结　果

2.1　两组患儿一般情况比较

两组患儿性别、年龄、体质量及异物在气管位置等一般情况比较差异无统计学意义（$P > 0.05$；表2）。

2.2　监测两组患儿术中术后生命征及血流动力学变化

R组生命征及血流动力学稳定，而S组仅于置镜后5 min心率略有下降（$P < 0.01$）；其余观察指标均$P > 0.05$，两组间比较差异无统计学意义（表3）。

表1　支气管镜置入条件评分标准

Table 1　The evaluation standards of brace bronchoscope condition

Project	3 points	2 points	1 points
Mandibular relaxation	Complete relaxation	Slight contraction	Stiff
Vocal position	Complete abduction	Intermediate position	Glottal close
Vocal activity	Nothing	Intermittent activity	Continuous activity or Close

表2　两组患儿一般资料及异物位置的比较

Table 2　Comparison of two groups of children patients with general information and foreign body position（$\bar{x} \pm s$ or cases）

Group	Cases	Age/years	Gender（male/female）	Body mass/kg	Foreign body in airway position	
					Left bronchus	Right bronchus
R	40	2.2 ± 0.4	24/16	14.1 ± 2.2	14	26
S	40	2.1 ± 0.5	22/18	13.6 ± 2.3	11	29
χ^2 or t		0.9877	0.2046	0.9936	0.5236	
P		0.3263	0.6510	0.3235	0.4693	

Group R: Rocuronium group; Group S: Succinylcholine group.

表3　两组患儿术中术后生命征及血流动力学观察

Table 3　Observation of life signs and hemodynamics in intraoperative and postoperative in two groups of children patients

Group	n	Heart rate/min			Hypoxemia（SPO_2/%）			$P_{ET}CO_2$/kPa		
		BM	AM5	ARFB	BM	AM5	ARFB	BM	AM5	ARFB
R	40	106.5 ± 8.4	102.4 ± 9.0	106.6 ± 8.1	97.4 ± 2.6	96.8 ± 2.9	96.8 ± 3.0	38.6 ± 3.0	37.5 ± 3.6	36.5 ± 4.0
S	40	105.3 ± 9.2	90.2 ± 13.6	108.2 ± 10.5	97.1 ± 2.8	96.7 ± 3.0	96.7 ± 3.1	37.9 ± 3.2	38.1 ± 3.8	37.0 ± 4.1
t		0.6072	4.7313	−0.7631	0.4966	0.1516	0.2932	1.0093	−0.7249	−0.5521
P		0.5442	< 0.01	0.4477	0.6209	0.8799	0.8838	0.3160	0.4707	0.5825

Group R & S: same as table 2. BM: Before the insertion of mirror; AM5: After insertion of mirror 5 min; ARFB: After removal of foreign body.

2.3 比较两组患儿术中术后并发症的发生情况

两组均无出现气管切开、纵膈气肿等,但S组患儿有出现体动(8例)、低氧血症(6例)、苏醒期躁动(6例)等并发症,而R组仅出现喉痉挛及苏醒期躁动各1例,两组间比较差异有统计学意义($P < 0.05$;表4)。

表4 两组患儿术中术后并发症的比较

Table 4 Comparison of intraoperative and postoperative complications in the two groups of children patients [cases(%)]

Group	n	Intraoperative complications				Postoperative complications				
		Hypoxemia ($SPO_2 < 85\%$)	Body movement	Hold one's breath	Cough	Hypoxemia ($SPO_2 < 85\%$)	Laryngeal spasm	Restlessness during recovery period	Stop breath	Postoperative 24 h muscle soreness
R	40	0	0	0	0	0	1(2.5)	1(2.5)	0	0
S	40	3(7.5)	8(20.0)	2(5.0)	2(5.0)	6(15.0)	1(2.5)	6(15.0)	1(2.5)	14(35.0)
χ^2		3.1169	8.8889	2.0513	2.0513	6.4865	0	3.9139	1.0127	16.967
P		0.0775	0.0029	0.1521	0.1521	0.0109	1.0000	0.0479	0.3143	< 0.001

Group R & S: same as table 2.

2.4 两组患儿术中追加药物及支气管镜置入条件比较

追加肌松药情况:R组患儿未再追加肌松药,S组所有患儿均需追加肌松药,次数1~2次,平均(1.8 ± 0.3)次,两组比较差别有统计学意义($P < 0.01$)。追加静注阿托品次数:R组患儿无需追加静注阿托品,而S组患儿均需追加,次数1~2次,平均(1.6 ± 0.5)次,两组比较差别有统计学意义($P < 0.01$)。两组患儿支气管镜置入条件比较差别无统计学意义($P > 0.05$;表5)。

表5 两组患儿追加肌松药、追加阿托品次数及支气管镜置入条件

Table 5 The times of intravenous injection with muscle relaxant and atropine and brace bronchoscope condition in two groups of children patients

Group	Additional muscle relaxant(frequency)	Additional atropine(frequency)	Brace bronchoscope condition [cases (%)]		
			Superior	Good	Poor
R	0	0	36(90.0)	4(10.0)	0(0)
S	1.8 ± 0.3	1.6 ± 0.5	35(87.5)	5(12.5)	0(0)
t or χ^2	$t = -37.9473$	$t = -20.1082$	$\chi^2 = 0.1252$		
P	< 0.001	< 0.001	0.7235		

Group R & S: same as table 2. $N = 40$

2.5 两组患儿不同时点肌松情况及拔管时间比较

分析两组患儿不同时点肌松程度测定值及拔管时间比较,发现除了肌松程度于支气管置入时$P > 0.05$,差异无统计学意义,其余观察指标均$P < 0.01$,在术后15 min S组患儿肌力恢复比R组明显,且术后R组患儿拔除气管插管时间比S组平均延长15 min,两组间比较差异有统计学意义($P < 0.01$;表6)。

2.6 术后24 h随访

术后24 h病房随访年龄大于3岁所有S组及R组患儿30例(由家属询问),其中S组(14例)、R组(16例)。S组患儿均表现为躯干及四肢肌肉酸痛(100%),R组患儿均无全身肌肉酸痛发生(0%),两组比较差别有统计学意义($P < 0.01$;表4)。

3 讨 论

小儿气管、支气管异物是耳鼻咽喉头颈外科常见危重急症,可危及患儿生命安全,其诊断主要依靠异物史、体征、CT检查等[4-5],确诊后均需手术治疗,多采用硬质支气管镜检取异物术[6-9]。若诊断或治疗不及时,易引起严重并发症。国内外

表6　两组患儿不同时点肌松程度及术后拔除导管时间比较

Table 6 Comparison of the degree of muscle relaxation at different time point and the time of extubation in two groups of children patients

Group	*n*	Different degrees of muscle relaxation/%				Time of extubation after operation/min
		Bronchoscopic placement	Tracheal intubation at the end of surgery	Postoperative 15 min	Postoperative 30 min	
R	40	100 ± 0	100 ± 0	80 ± 5	17 ± 4	30.2 ± 3.2
S	40	100 ± 0	90 ± 3	36 ± 9	12 ± 5	15.2 ± 6.3
t		0	21.0819	27.0290	4.9387	13.4258
P		1.000	< 0.001	< 0.001	< 0.001	< 0.001

Group R & S: same as table 2.

多家专门机构根据流行病学特点研究显示由于患儿大脑系统发育不完善，呼吸与循环代偿能力较差，并且气道较狭小、反射敏感，易在麻醉及手术过程中诱发应激反应，稍有疏忽即引起喉痉挛、气道损伤、穿孔、纵膈气肿、呼吸停止、窒息死亡等并发症，其中最严重为窒息死亡，发生率约为0.48% ~ 1.28%[10-12]。

小儿支气管镜检查取异物手术虽历时较短，但因手术时与麻醉共用同一气道，如何保证患儿通气、氧供及术者与麻醉者良好配合是一个相当大的难题，手术及麻醉风险较高，手术能否成功除与术者的经验和技巧有关，还与术中如何解决麻醉过程中的通气以及如何应用肌松药等问题息息相关[13-14]。近几年来，随着高频喷射通气在手术中的应用，解决了气道异物取出过程中的通气问题，同时术中应用肌松药有助于麻醉医师在麻醉深度平衡的调控、其他麻醉辅助药的使用等方面更加得心应手，使气道相对活动减轻，为术者创造更佳的插管、手术条件及减少手术中对气管、支气管的刺激，利于异物取出[2]。但是，由于手术操作困难程度存在不确定性及手术时间长短不一等问题，术者与麻醉者对肌松药类型的选择存在一定争议。这就需要手术医师及麻醉医师在术前、术中根据病情密切沟通，依据患儿体质、生命征、置管难易程度、异物性质、取出难易情况及手术的长短来选择使用肌松药的类型[15-16]。

本研究通过对比罗库溴铵和琥珀胆碱两类不同时效肌松药在气管、支气管异物取出术中的麻醉效果及疗效分析，体会到对于位于气管总道、存留时间短、或单一、较易取出的普通异物，估计手术时间较短，不需频繁进出支气管镜，术中、术后不会出现声门区、气管损伤等并发症的，可采用琥珀胆碱等短效肌松药；而对于难取、存留时间较长、位置较深在及特殊异物且术中需要反复多次进出支气管镜，考虑手术时间会较长，术中、术后易出现支气管痉挛或发生窒息的，建议采用罗库溴氨等中长效肌松药。因为琥珀胆碱是超短时效去极化肌松药，适用于短时间手术，其药理学特点是起效快、作用时间短（5 ~ 10 min）；但琥珀胆碱存在较多副作用，如可引起恶性高热、血清 K^+ 升高、肌颤、术后肌肉酸痛等诸多不良反应，主要与患儿骨骼肌强直性收缩产生大量能量和术中术后肌纤维之间不协调不同步的成束收缩及血清肌酐磷酸激酶增加等因素有关[17]，本组中有14例年龄大于3岁的患儿在使用琥珀胆碱肌松药术后24 h随访均出现肌肉酸痛。研究中发现由于琥珀胆碱作用时间短，手术中往往需要多次追加药物，而在追加琥珀胆碱时容易发生心动过缓，甚至有出现心跳停止的报道，因而追加琥珀胆碱前预防性应用阿托品是必要的[18]。本组中即有1例患儿因术中麻醉较浅且心率较快须追加琥珀胆碱前未使用阿托品，追加琥珀胆碱仅20 s即出现心率急剧下降，紧急胸外按压及静滴阿托品始脱离危险。而罗库溴铵是中时效单季铵甾体类非去极化肌松药，具有起效快、作用时间中等和对血液动力学影响较小等药理学特点，其95%有效药物剂量（ED_{95}）为0.3 mg/kg。应用3倍 ED_{95} 罗库溴铵时，起效时间可缩短至1 min[19]。本研究应用0.9 mg/kg罗库溴铵于气道异物支气管镜检查手术中可取得与应用琥珀胆碱相似的肌松程度，而且应用罗库溴铵单次静脉注射，在气道异物手术中可维持麻醉时效10 ~ 15 min以上，基本能满足手术过程而无需再追加肌松药，麻醉及手术过程显得更加从容、术中检查气道或夹取异物时不出现支气管痉挛，

生命体征亦更为平稳。R组中有10例术中因异物难取出须进出支气管镜2~3次,均未出现呛咳、低氧血症、窒息等其他不良反应。同时于术后24 h随访年龄大于3岁的16例R组患儿均无全身肌肉酸痛发生,舒适满意度较高,说明支气管镜检查手术中应用罗库溴铵可提高术后患儿的舒适度。这与罗库溴铵不释放组胺、消除代谢物主要依靠肝脏肾脏及术中、术后无肌纤维成束收缩等因素有关。

支气管镜检查取异物多数手术时间不易掌控,手术结束时全麻药及肌松药作用仍未完全消退,因而两组患儿术后肌力未恢复时插入气管导管进行辅助呼吸可预防出现意外,利于气道稳定性的恢复及等待拔管时机。本组80例患儿术后均实施气管插管进行呼吸管控。虽然R组患儿在术后15 min肌力恢复比S组较慢,拔管时间比S组平均延长15 min,但对于术后进食时间、活动或出院时间等并无明显影响。

国内外有学者研究在支气管异物取出术中多种麻醉方法,包括肌松药+七氟醚,丙泊酚+七氟醚,肌松药+瑞芬太尼、全麻+喉部喷雾利多卡因或涂抹恩纳乳膏(EMLA Cream)等[2,20-21],但目前尚没有循证医学明确取支气管异物最理想的麻醉手段,而是应根据病情变化权衡利弊来选用最佳的麻醉方法配合临床治疗[11,22-24],为手术顺利完成提供最大的帮助。

本研究说明对于难取、存留时间较长、位置较深在及特殊异物且术中需要反复多次进出支气管镜的小儿气道异物,罗库溴铵类型中时效肌松药在气道异物取出术中肌松效果更佳,置镜时能顺利通过声门区,术中检查气道或夹取异物时不出现支气管痉挛等并发症,为术者提供良好的手术条件,且麻醉医师更容易掌控术中的麻醉深度。

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