Original Article

Rocuronium versus suxamethonium for rapid sequence induction of general anaesthesia for caesarean section: influence on neonatal outcomes

M. Kosinova, P. Stourac, M. Adamus, D. Seidlova, T. Pavlik, P. Janku, I. Krikava, Z. Mrozek, M. Prochazka, J. Klucka, R. Stoudek, I. Bartikova, H. Harazim, H. Robotkova, K. Hejduk, Z. Hodicka, M. Kirchnerova, J. Francakova, L. Obare Pyszkova, J. Hlozkova, P. Sevcik

PII: S0959-289X(17)30202-9
DOI: http://dx.doi.org/10.1016/j.ijoa.2017.05.001
Reference: YIJOA 2570

To appear in: *International Journal of Obstetric Anesthesia*

Accepted Date: 2 May 2017

Please cite this article as: Kosinova, M., Stourac, P., Adamus, M., Seidlova, D., Pavlik, T., Janku, P., Krikava, I., Mrozek, Z., Prochazka, M., Klucka, J., Stoudek, R., Bartikova, I., Harazim, H., Robotkova, H., Hejduk, K., Hodicka, Z., Kirchnerova, M., Francakova, J., Obare Pyszkova, L., Hlozkova, J., Sevcik, P., Rocuronium versus suxamethonium for rapid sequence induction of general anaesthesia for caesarean section: influence on neonatal outcomes, *International Journal of Obstetric Anesthesia* (2017), doi: http://dx.doi.org/10.1016/j.ijoa.2017.05.001

IJOA 16-00226

ORIGINAL ARTICLE

Rocuronium versus suxamethonium for rapid sequence induction of general anaesthesia for caesarean section: influence on neonatal outcomes

M. Kosinova,[a] P. Stourac,[b] M. Adamus,[c] D. Seidlova,[d] T. Pavlik,[e] P. Janku,[f] I. Krikava,[b] Z. Mrozek,[c] M. Prochazka,[g] J. Klucka,[b] R. Stoudek,[b] I. Bartikova,[a] H. Harazim,[a] H. Robotkova,[c] K. Hejduk,[e] Z, Hodicka,[f] M. Kirchnerova,[c] J. Francakova,[c] L. Obare Pyszkova,[c] J. Hlozkova,[c] P. Sevcik[h]

[a]*Department of Anesthesiology and Intensive Care Medicine, University Hospital Brno, Faculty of Medicine, Masaryk University, Brno, Czech Republic*

[b]*Department of Pediatric Anesthesiology and Intensive Care Medicine, University Hospital Brno, Faculty of Medicine, Masaryk University, Brno, Czech Republic*

[c]*Department of Anesthesiology and Intensive Care Medicine, University Hospital Olomouc, Faculty of Medicine and Dentistry, Palacky University Olomouc, Olomouc, Czech Republic*

[d]*2nd Anesthesiological Department, University Hospital Brno, Brno, Czech Republic*

[e]*Institute of Biostatistics and Analyses, Faculty of Medicine, Masaryk University, Brno, Czech Republic*

[f]*Department of Obstetrics and Gynecology, University Hospital Brno, Faculty of Medicine, Masaryk University, Brno, Czech Republic*

[g]*Department of Midwifery, University Hospital Olomouc, Faculty of Health Sciences, Palacky University Olomouc, Olomouc, Czech Republic*

[h]*Department of Anesthesiology and Intensive Care Medicine, University Hospital Ostrava, and Faculty of Medicine, University of Ostrava, Ostrava, Czech Republic*

Short title: Rocuronium versus suxamethonium

The preliminary results of this study were presented at the following congresses: Euroanaesthesia 2013, Barcelona, Spain; Euroanaesthesia 2014, Stockholm, Sweden; Euroanaesthesia 2015, Berlin, Germany; Anesthesiology 2015, San Diego, USA; Euroanaesthesia 2016, London, UK.

Correspondence to: Assoc. Prof. Petr Stourac, MD, PhD, Department of Pediatric Anesthesiology and Intensive Care Medicine, University Hospital Brno, Faculty of Medicine, Masaryk University, Jihlavska 20, Brno, 625 00, Czech Republic.

E-mail address: petr.stourac@gmail.com

ABSTRACT

Background: In a previous study we compared rocuronium and suxamethonium for rapid-sequence induction of general anaesthesia for caesarean section and found no difference in maternal outcome. There was however, a significant difference in Apgar scores. As this was a secondary outcome, we extended the study to explore this finding on a larger sample.

Methods: We included 488 parturients of whom 240 were women from the original study. The women were randomly assigned to receive either rocuronium 1 mg/kg (ROC n=245) or suxamethonium 1 mg/kg (SUX n=243) after propofol 2 mg/kg. Anaesthesia was maintained with up to 50 % nitrous oxide and up to 1 MAC of sevoflurane until the umbilical cord was clamped. We compared neonatal outcome using Apgar scores and umbilical cord blood gases.

Results: Data were analysed for 525 newborns (ROC n=263 vs. SUX n=262). There was a statistically significant difference in the proportion of Apgar scores <7 at 1 min (ROC 17.5% vs. SUX 10.3%, *P*=0.023) but no difference at 5 min (ROC 8% vs. SUX 4.2%, *P*=0.1) or 10 min (ROC 3.0% vs. SUX 1.9%, *P*=0.58). There was no difference between groups in other measured outcomes.

Conclusion: The use of rocuronium was associated with lower Apgar scores at 1 min compared with suxamethonium. The clinical significance of this is unclear and warrants further investigation.

Keywords: Rocuronium; Suxamethonium; Caesarean section; Neonatal outcome; Apgar score

Introduction

In recent years, rocuronium has been described as an alternative to suxamethonium for rapid-sequence induction of general anesthesia (GA) for caesarean section (CS). However, although maternal outcomes have been investigated,[1] there are no large randomized trials of the influence of rocuronium on neonates.

The possible neonatal effects of transfer of neuromuscular blocking agents from the maternal to the fetal circulation is an important consideration. Suxamethonium has been the first-line agent for over 40 years.[2] Guay et al. reported no partial curarisation of neonates at clinical doses of suxamethonium (1mg/kg), apart from neonates born to mothers with atypical plasma pseudocholinesterase.[3] Abouleish et al. published the first prospective study on the use of rocuronium in CS more than 20 years ago.[4] They measured plasma concentrations of rocuronium and reported an umbilical vein:maternal vein ratio of 0.16 at the time of delivery when rocuronium was administered in a dose of 0.6 mg/kg. There are no data on

transplacental transfer of rocuronium given in higher doses which are necessary to obtain optimal intubation conditions with comparable time of onset to suxamethonium.[1,5] However, placental transfer proportional to the maternal dose is expected.[6]

In a previous study, we investigated time to tracheal intubation following rocuronium or suxamethonium in 240 women undergoing CS under GA.[1] In that study, Apgar scores of neonates of women administered rocuronium were significantly lower at 1 min and 5 min; however, this was a secondary outcome for which the study was not powered. In the present investigation, we sought to confirm these findings by expanding the patient sample to 488 women.

Methods

In total, 488 parturients (525 newborns) were evaluated in this follow-up study. Data from our initial study were collected from December 2012 to December 2013. Following a one-month gap in January 2014 while awaiting ethics committee approval for continuation of the original study, data from a second cohort of patients was collected up to January 2015 and added to the original data for pooled analysis. Two university hospitals participated in this randomized, single-blinded (parturient), parallel-group, controlled study: the Department of Anesthesiology and Intensive Care Medicine and 2nd Anesthesiological Department at the University Hospital, Brno, Czech Republic and the Department of Anesthesiology and Intensive Care Medicine, the University Hospital, Olomouc, Czech Republic. The allocation ratio into study groups was 1:1. The study was approved by the institutional ethics committees of both centres.

The University Hospital in Brno is a perinatal centre for the region of South Moravia with a population of almost 1.2 million and more than 6000 deliveries per year (CS rate 22% with 30% under GA). The University Hospital in Olomouc is the perinatal centre for the Olomouc region with an approximate population of 650 000 and more than 2600 deliveries per year (CS rate 31% with 55% under GA). Inclusion criteria in the original study were: age 14–60 years and CS performed under GA. Exclusion criteria were: anaesthesiologist or obstetrician opposition to patient inclusion, allergy or intolerance to one or more of the study drugs, allergies or reactions to iodine and patient refusal or no written informed consent. Patients were excluded from analysis if data for Apgar scores were missing, or if there was failure of the neuromuscular blockade monitor.

Each patient was randomized to either the rocuronium (ROC) group or suxamethonium (SUX) group. Stratified block randomization was used for generating the

subject allocation sequence. Stratification took into account four variables: participating centre, type of CS (scheduled or unscheduled), age (<30 or ≥30 years), and body mass index (BMI) (<30 or ≥30 kg/m^2). For each stratum, the statistician generated the random allocation sequence for the two treatment groups. A computer random number generator was used to randomly select permuted blocks of four patients and an equal allocation ratio. Sequentially numbered containers were used for individual strata and group assignments were concealed in sequentially numbered, opaque, and sealed envelopes. Each envelope was opened immediately before the induction of general anesthesia, and the patient was assigned to either the ROC or the SUX group.

The anesthesiologist was not blinded. From entry to the operating room until the skin incision, the patient was kept in a 15 degree left lateral tilt position. During three minutes a TOF WATCH SX (Organon, Gouda, The Netherlands) was fixed on the left forearm for monitoring of neuromuscular block (modes: single twitch, train of-four (TOF) or post-tetanic count (PTC)). Anaesthesia was induced with propofol 2 mg/kg followed by either rocuronium 1 mg/kg or suxamethonium 1 mg/kg. No opioids were given before delivery. Tracheal intubation was performed when single twitch decreased to 10 % or when visible twitches disappeared. Until the umbilical cord was clamped, nitrous oxide up to 50 % and sevoflurane up to 1 MAC (minimum alveolar concentration) was used for anaesthesia maintenance.

The anaesthesiologist recorded maternal characteristics (age, weight before pregnancy, weight at delivery, change in weight, height, BMI at delivery, gravidity, parity, American Society of Anesthesiologist physical status score, Mallampati score, singleton or multiple birth, planning of CS) and newborn characteristics (gestational age, weight, Apgar scores at 1, 5 and 10 min as assessed by an experienced neonatologist who was blinded to patient group), prenatal monitoring including CTG (cardiotocograph) or ST analysis (STAN) monitor and amniotic fluid turbidity in a paper case report form. Umbilical cord blood gases results were collected by the research team who also entered any missing data in the paper case report. Members of the research team was not blinded to the study group. Anonymized data were recorded in electronic case report form of the study database (RocSugIO.registry.cz; TrialDB, USA).

Statistical analysis

The primary end point was neonatal outcome, which was evaluated using Apgar scores and umbilical arterial blood gas parameters. The Apgar score was assessed as categorized (<7 or ≥7). No a priori sample size estimation was performed for neonatal outcome evaluation

(sample size estimation in the original study was based on time needed to tracheal intubation of the parturient).[1] However, the final sample size of 488 parturients enabled us to identify 10% difference in the incidence of 1-min Apgar scores <7 with 80 % power given that the incidence of 1-min Apgar scores <7 was no more than 15 % in the reference (SUX) group).

We analyzed data of all newborns collectively and separately, after excluding those with fetal pathology or signs of fetal hypoxia (leaving only those with clear amniotic fluid, physiological CTG, gestational age ≥37 weeks) in both unscheduled and scheduled CS. Finally, we evaluated only neonates from women who underwent scheduled CS with no fetal compromise (clear amniotic fluid, physiological CTG, gestational age ≥37 weeks) to eliminate possible confounding factors on Apgar score.

Standard frequency tables and summary statistics (mean, standard deviation (SD), median, range) were used to describe the baseline demographic and clinical characteristics. The Fisher exact test was used for analysis of the categorized 1-, 5- and 10-min minute Apgar scores. The Mann-Whitney test was used to assess differences in continuous variables. All analyses were performed according to the intention-to-treat principle. To examine the influence of unscheduled CS, neonatal outcomes of ROC versus SUX groups were evaluated separately in scheduled CS. For the primary outcome, a *P* value <0.05 was considered statistically significant. All analyses were performed with R software for Windows (version 2.13.0; R Development Core Team, Statistics Department (http://www.r-project.org/).

Results

We enrolled 488 parturients (ROC: n=245, SUX: n=243) and 525 newborns (ROC:n=263, SUX: n=262). The inclusion rate was 27 %, as 1773 parturients met the inclusion criteria in total. The Consolidated Standards of Reporting Trials (CONSORT) diagram for the study is shown in Fig. 1. Characteristics of parturients and newborns are shown in Tables 1 and 2. There were no significant differences in demographic characteristics between groups. There was a statistically significant difference between groups in the incidence of Apgar scores <7 at 1 min (ROC: n=46 (17.5%) vs. SUX: n=27 (10.3%), *P*=0.023) but no difference at 5 min and 10 min. There was no difference between groups in umbilical arterial blood gases.

When we excluded from analysis newborns with fetal pathology or signs of fetal hypoxia (turbid amniotic fluid, suspect or pathologic CTG, gestational age <37 weeks), we confirmed the results for the 1-min Apgar scores in the ROC group. When we evaluated only neonates from scheduled CSs with gestational age ≥37 weeks, physiological CTG and clear amniotic fluid, the significant difference in 1-min Apgar scores >7 remained (ROC: n=10

(10.5%) vs. SUX: n=2 (2.3%); *P*=0.035). All other parameters of neonatal outcome (5-min and 10-miin Apgar scores and umbilical arterial cord blood gases) remained non-significant after sample adjustment (Table 3).

Discussion

We present the results of a randomized controlled trial which was extended for one year to verify neonatal outcome of using either rocuronium or suxamethonium for rapid-sequence induction in CS under GA.[1] To the best of our knowledge, this is the first trial to investigate neonatal outcome following maternal administration of either rocuronium or suxamethonium for induction of neuromuscular blockade at GA for CS.

As an Apgar score >7 is considered to represent good neonatal outcome, we divided data into two categories: Apgar score <7 and ≥7.[7] Using this cut-off value we found a statistically significant difference between groups although there was no difference in other assessed measures of neonatal outcome. Even after exclusion of possible confounding factors, the significant difference in 1-min Apgar scores remained. However, analysis of neonatal outcomes in the subgroup defined by women undergoing scheduled CS with no fetal compromise is underpowered because of the limited sample size; therefore these results should be interpreted with caution.

The Apgar score as an indicator of neonatal outcome has limitations because it depends on the experience of the assessor and is to an extent subjective; however, it is the most common approach to evaluate neonatal outcome in the Czech Republic and worldwide. Bashambu et al. reported an almost perfect agreement among 335 neonatologists evaluating 1- and 5-min Apgar scores in the full-term infant. Disagreement was found only in preterm infants unless infants were apnoeic and limp.[8] We used the Apgar score because it is standardized, well-established in our hospital and is always evaluated by experienced neonatologists, who in this case were blinded to the muscle relaxant used. Since neonatal outcome was not the primary endpoint of our original study, we were not able to retrospectively analyze the individual components of each Apgar score because that was not a part of the case report form; thus, it is not possible to identify which components of the Apgar score were specifically influenced by the muscle relaxant selection.

Neonates were assessed and treated in accordance with European Resuscitation Council guidelines (ERC guidelines 2010).[9] Despite the well-established practice of Apgar scoring, it may not be as objective as other variables such as umbilical arterial blood gases. Recent studies have demonstrated the importance of obtaining the umbilical cord blood

sample for detecting fetal and subsequently, neonatal acidemia which is associated with higher rates of adverse outcomes.[7,10] Sabol et al. found that neonatal acidemia may occur even when the 5-min Apgar score is >7 and that these neonates are at higher risk of adverse outcome; the severity of acidemia increasing the risk.[7] This shows the importance of umbilical artery acid-base status which can be considered an objective marker of neonatal outcome.

The difference in 1-min Apgar scores in our study could be explained by the pharmacodynamics of rocuronium and suxamethonium.[11, 12] Adamus et al.[11] compared the effect of age and gender on the pharmacodynamic parameters of rocuronium and found shorter duration in younger people and in males. These authors did not include patients aged <20 years but we assume that even in children, the duration of rocuronium-induced neuromuscular block is as short as in young adults and maybe even shorter.[11] Although rocuronium in a dose of 0.6 mg/kg has been shown to cross the placenta with an umbilical vein:maternal ratio of 0.16 at the time of delivery,[4] the tissue exposure of the neonate to rocuronium is much lower because of the exposure of rocuronium to first pass metabolism in the neonatal liver and further dilution in the neonatal circulation. It is possible that the finding of our study could be explained by the dose-dependent duration characteristics of rocuronium.[12] If we assume that the duration of possible neuromuscular blockade in the neonate is <5 min after delivery, this may explain why the 5-min Apgar scores were relatively unaffected. To ascertain the precise duration of blockade and to know if there is any clinically significant neuromuscular blockade in the neonate after maternal administration of rocuronium at CS in dose of 1 mg/kg there is a need for further investigation. This should include measurement of rocuronium concentration in neonatal blood and its decrease in the minutes after delivery. In comparison to rocuronium, suxamethonium does not cross the placenta in demonstrable quantities and neonates are not affected.[13]

If neonates demonstrated clinical signs of neuromuscular blockade during the study, we were prepared to administer sugammadex. However, our neonatologists did not report any clinical signs of residual neuromuscular blockade in any neonate during the study period. There are reports of neonatal administration of sugammadex for rocuronium reversal.[14-17] However, to the best of our knowledge, there are no reports in the setting of maternal administration of rocuronium at CS. There is one case of successful use of sugammadex to reverse both peripheral and central effects of rocuronium in a neonate.[15]

There are a number of limitations to this study. The endpoint presented in this paper was not the primary endpoint of our initial study.[1] An important limitation is that we

performed a follow up investigation of a secondary outcome of our initial study on an extended sample without an a priori power analysis. Because of the absence of a prospective power analysis we cannot exclude the possibility of a type-1 statistical error. However, in studies where safety is the primary focus, type-2 error is usually of more concern and we wanted to emphasize the potential association between the rocuronium group and lower Apgar scores. The absence of individual components of Apgar score was another limitation as was absence of stratified randomization according to the neonate (stratification of parturients) but no statistically significant differences in characteristics or demographic data of the newborns were found. Further, we did not exclude parturients with twins. There were also some deliveries where we did not manage to obtain the umbilical cord blood sample. Thus, 11 samples in the ROC and 13 samples in the SUX group are missing from the data.

In conclusion rocuronium 1.0 mg/kg for rapid sequence induction for CS was associated with lower 1-min Apgar scores compared with suxamethonium 1 mg/kg. However, since there was no difference in 5-min and 10-min Apgar scores and no difference in umbilical cord arterial blood gases, the clinical relevance of our results is uncertain. Further investigation of the possible neonatal effects of maternally-administered rocuronium is required.

Acknowledgements

For data collection and support, we would like to thank staff at the University Hospital Brno (Brno, Czech Republic): Bosakova Kamila, Fialova Martina, Gal Roman, Hanounova Katerina, Jonasek Martin, Popkova Jana, Ruzickova Aranka, Toukalkova Michaela, Vranova Olga, Vyplelova Yvona and Zemanova Jitka. We would also like to thank staff at the Institute of Biostatistics and Analyses, Faculty of Medicine of Masaryk University (Brno, Czech Republic): Dusek Ladislav, Schwarz Daniel, and Zelinkova Hana.

Disclosure

This study received financial support from the Czech Ministry of Health: Internal Grant Agency (ID: NT 13906-4/2012). The study was registered at ClinicalTrials.gov (ID: NCT01718236). All authors declare no conflicts of interest.

References

1. Stourac P, Adamus M, Seidlova D. et al. Low-dose or high-dose rocuronium reversed with neostigmine or sugammadex for cesarean delivery anesthesia: A randomized

controlled non-inferiority trial of time to tracheal intubation and extubation. Anesth Analg 2016, 122: 1536–45.

2. Stept WJ, Safar P. Rapid induction/intubation for prevention of gastric-content aspiration. Anesth Analg 1970, 49: 633-6.
3. Guay J, Grenier Y, Varin F. Clinical pharmacokinetics of neuromuscular relaxants in pregnancy. Clin pharmacokinet 1998, 34: 483-496.
4. Abouleish E, Abboud T, Lechevalier T et al. Rocuronium (Org 9426) for caesarean section. Br J Anaesth 1994, 73: 336-41.
5. Abu-Halaweh SA, Massad IM, Abu-Ali HM, et al. Rapid sequence induction and intubation with 1 mg/kg rocuronium bromide in cesarean section, comparison with suxamethonium. Saudi Med J 2007, 28: 1393-6.
6. Sharp LM, Levy DM. Rapid sequence induction in obstetrics revisited. Curr Opin Anesthesiol 2009, 22: 357-61.
7. Sabol BA, Caughey AB. Acidemia in neonates with a 5-minute Apgar score of 7 or greater - What are the outcomes? Am J Obstet Gynecol 2016 May 31. pii: S0002-9378(16)30251-4. doi: 10.1016/j.ajog.2016.05.035. [Epub ahead of print]
8. Bashambu MT, Whitehead H, Hibbs AM, et al. Evaluation of interobserver agreement of Apgar scoring in preterm infants. Pediatrics 2012, 130: e982-e987.
9. Richmond S, Wyllie J. European Resuscitation Council Guidelines for Resuscitation 2010 Section 7. Resuscitation of babies at birth. Resuscitation. 2010; 10: 1389-99.
10. Malin GL, Morris RK, Khan KS. Strength of association between umbilical cord pH and perinatal and long term outcomes: systematic review and meta-analysis. BMJ 2010; 340: c1471.
11. Adamus M, Hrabalek L, Wanek T, et al. Influence of age and gender on the pharmacodynamic parameters of rocuronium during total intravenous anesthesia. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2011; 155:347-53.
12. Magorian T, Flannery KB, Miller RD. Comparison of rocuronium, succinylcholine, and vecuronium for rapid-sequence induction of anesthesia in adult patients. Anesthesiology 1993; 79: 913-8.
13. Moya F, Kvisselgaard N. The placental transmission of succinylcholine. Anesthesiology 1961; 22: 1-6.
14. Ozmete O, Bali C, Ergenoglu P et al. Anesthesia management and sugammadex experience in a neonate for Galen vein aneurysm. J Clin Anesth 2016; 13: 36-3.

15. Langley RJ, McFadzean J, McCormack J. The presumed central nervous system effects of rocuronium in a neonate and its reversal with sugammadex. Pediatr Anesth 2016; 26: 109-11.
16. Carlos RV, Torres ML, de Boer HD. Rocuronium and sugammadex in a 3 days old neonate for draining an ovarian cyst. Neuromuscular management and review of the literature. Rev Bras Anestesiol 2016; 66: 430-2.
17. González Cárdenas VH, Munar González FD. Sugammadex in the neonatal patient. Rev Colomb Anestesiol 2013; 41: 171-4.

Table 1 Patient characteristics

	Rocuronium (n=245)	Suxamethonium (n=243)
Age (years)	31 ± 5.3	31 ± 5.2
	31 [18–45]	31 [18–45]
Weight: pre pregnancy (kg)	70 ± 17.7	69 ± 15.9
	65 [37–137]	65 [42–142]
Weight: delivery (kg)	83 ± 17.3	82 ± 16.4
	80 [47–150]	80 [52–151]
Weight gain (kg)	13 ± 5.7	14 ± 6.1
	13 [-10–33]	13 [-13–33]
Height (cm)	166 ± 6.4	165 ± 7.1
	168 [150–183]	165 [120–185]
BMI: delivery (kg/m^2)	30 ± 5.6	30 ± 5.9
	28 [19–51]	29 [20–59]
Gestation (weeks)	38 ± 2.7	38 ± 2.4
	38 [25–41]	38 [28–41]
Gestation ≤36 weeks	51 (20.8%)	49 (20.2%)
Gravidity		
1	111 (45.3%)	100 (41.2%)
2	67 (27.3%)	69 (28.4%)
3	36 (14.7%)	42 (17.3%)
≥4	31 (12.7%)	31 (12.8%)
Parity		
1	135 (55.1%)	132 (54.3%)
2	77 (31.4%)	77 (31.7%)
3	25 (10.2%)	24 (9.9%)
≥4	8 (3.3%)	9 (3.7%)
ASA		
1	118 (42.2%)	116 (47.7%)
2	105 (42.9%)	109 (44.9%)
3	14 (5.7%)	12 (4.9%)
4	8 (3.3%)	6 (2.5%)
Number of fetuses		
Single	225 (91.8%)	222 (91.4%)
Twin	19 (7.8%)	20 (8.2%)
Triplet	1 (0.4%)	1 (0.4%)
Category of CS		
Unscheduled	139 (56.7%)	136 (56.0%)
Scheduled	106 (43.3%)	107 (44.0%)

Data are mean±SD, median [range] or number (%)

BMI: body mass index; ASA: American Society of Anesthesiologists

Table 2 Neonatal data

	Rocuronium (n=263)	Suxamethonium (n=262)	*P* value
Gestation (weeks)	37 ± 2.8 38 [25–41]	38 ± 2.5 38 [28–41]	0.99
Birthweight (g)	2982 ± 794 3120 [560–4600]	30336 ± 782 3125 [490–5140]	0.48
Umbilical artery*			
pH	7.28 ± 0.08 7.29 [6.73–7.45]	7.28 ± 0.08 7.29 [6.31–7.42]	0.76
PCO2 (kPa)	6.9 ± 1.4 6.9 [3.7–18.9]	6.7 ± 1.0 6.8 [3.1–9.8]	0.24
PO2 (kPa)	3.9 ± 2.3 3.5 [0.5–21.7	3.9 ± 1.8 3.6 [0.7–21.5]	0.45
Base excess (mEq/L)	-3.4 ± 4.0 -2.8 [-23.3–12.7]	-3.5 ± 2.8 -3.1 [-14.2–7.7]	0.42
Induction–cord clamping time† (s)	331 ± 111 312 [150–878]	315 ± 87 296 [180–720]	0.18
Apgar score <7			
1 min	46 (17.5%)	27 (10.3%)	0.023
5 min	21 (8.0%)	11 (4.2%)	0.1
10 min	8 (3.0%)	5 (1.9%)	0.58
Fetal heart monitoring	258 (98%)	254 (97%)	
Fetal heart trace			0.52
Normal	175 (67.8%)	160 (63.0%)	
Suspicious	32 (12.4%)	36 (14.2%)	
Pathological	51 (19.8%)	58 (22.8%)	
Amniotic fluid			0.59
Clear	230 (87.5%)	234 (89.3%)	
Turbid	33 (12.5%)	28 (10.7%)	

Data are mean ± SD, median [range] or number (%)

Data included for individual neonates in multiple pregnancy

*missing data on 11 neonates in rocuronium group and 13 neonates in suxamethonium group

†time from completion of propofol injection

Table 3 Neonatal outcome in those babies with clear amniotic fluid, normal fetal heart rate and gestation ≥37 weeks

	Rocuronium (n=135)	Suxamethonium (n=114)	*P* value
Birthweight (g)	3271 ± 532	3345 ± 576	0.30
	3300 [1700–4600]	3340 [1800–5140]	
Umbilical artery pH	7.30 ± 0.04	7.29 ± 0.04	0.55
	7.30 [7.08–7.45]	7.29 [7.13–7.37]	
Apgar score <7			
1 min	15 (11.1%)	3 (2.6%)	0.013
5 min	6 (4.4%)	1 (0.9%)	0.13
10 min	1 (0.7%)	0	1
Scheduled deliveries	95	87	
Birthweight	3312 ± 476	3367 ± 595	0.43
	3320 [2120–4600]	3375 [1800–5140]	
Umbilical artery pH	7.29 ± 0.04	7.29 ±0.04	0.43
	7.30 [7.20–7.45]	7.29 [7.22–7.37]	
Apgar score <7			
1 min	10 (10.5%)	2 (2.3%)	0.035
5 min	3 (3.2%)	1 (1.1%)	0.62
10 min	0	0	

Data are mean ± SD, median [range] or number (%)

IJOA 16-00226

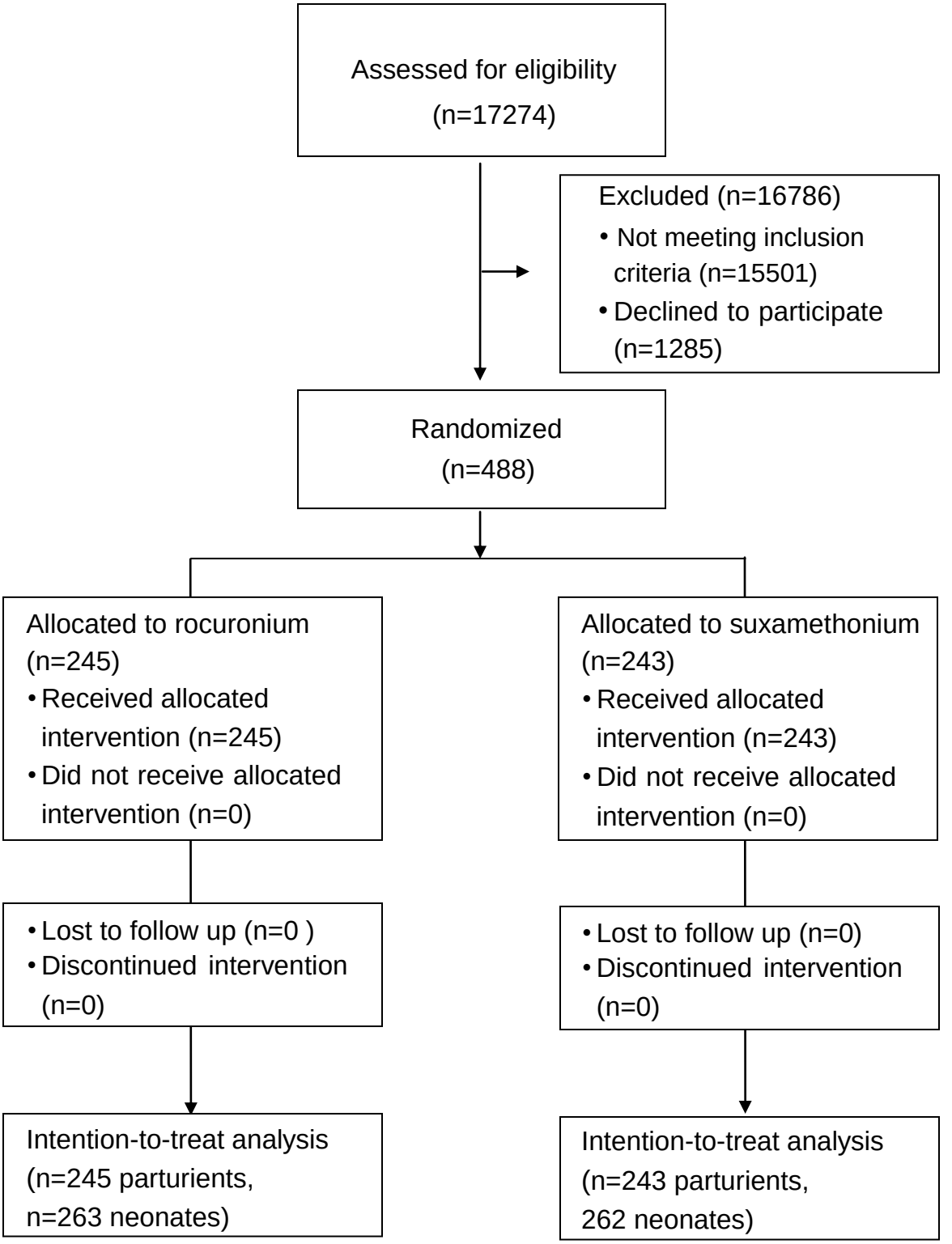
Figure Legends

Fig. 1 CONSORT flow chart diagram

IJOA 16-00226

Highlights

- This is an extension study of a previous publication
- Women were randomization to receive rocuronium or suxamethonium for caesarean section
- There were more 1-min Apgar scores <7 with rocuronium
- There were no differences in 5-min or 10-min Apgar scores
- There were no difference in umbilical arterial blood gases


Assessed for eligibility
(n=17274)
Excluded (n=16786)
• Not meeting inclusion criteria (n=15501)
• Declined to participate (n=1285)
Randomized
(n=488)
Allocated to rocuronium
(n=245)
• Received allocated intervention (n=245)
• Did not receive allocated intervention (n=0)
Allocated to suxamethonium
(n=243)
• Received allocated intervention (n=243)
• Did not receive allocated intervention (n=0)
• Lost to follow up (n=0)
• Discontinued intervention (n=0)
• Lost to follow up (n=0)
• Discontinued intervention (n=0)
Intention-to-treat analysis
(n=245 parturients,
n=263 neonates)
Intention-to-treat analysis
(n=243 parturients,
262 neonates)