Onset of vecuronium neuromuscular block is more rapid in patients undergoing Caesarean section

Anis Baraka MD, Samar Jabbour MD,
Zafer Tabboush MD, Abla Sibai MS,
Antoine Bijjani MD, Karam Karam MD

This investigation was carried out in ten patients undergoing elective Caesarean section and the results were compared with those of a control group of ten nonpregnant females of the same age group. The study investigated the onset of vecuronium neuromuscular block and the conditions of tracheal intubation when ketamine (1.5 mg · kg^{-1})-vecuronium 100 μg · kg^{-1}) sequence was used for rapid-sequence induction of anaesthesia. The ulnar nerve was stimulated supra-maximally at the wrist with train-of-four stimuli every 20 sec, and the electromyographic response of the adductor pollicis muscle was displayed. The onset of 50% neuromuscular block as monitored by electromyography was shorter in the Caesarean group (80 ± 30 sec) than in the control group (144 ± 43 sec). The conditions of intubation at 50% block were adequate in both groups. Also, the onset of 90% block was shorter in the Caesarean group. The time of recovery to T_1/control ratio of 25% was longer in the Caesarean group (46 ± 10 min) than in the control patients (28 ± 10 min). The results show that administration of vecuronium according to body weight results in a more rapid onset and delayed recovery of neuromuscular block in pregnant women undergoing Caesarean section than in the nonpregnant control patients.

Cette étude fut conduite chez dix patientes devant subir une césarienne élective et les résultats furent comparés à un groupe contrôle de dix patientes non gravides ayant le même âge. Cette étude investigue l'installation du bloc neuromusculaire après vécuronium et les conditions d'intubation trachéale à la kétamine (1,5 mg · kg^{-1})-vécuronium (100 μg · kg^{-1}) qui ont été utilisés pour une induction rapide de l'anesthésie. Le nerf cubital fut stimulé de façon supramaximale au niveau du poignet avec l'ondée-de-quatre (train-of-four) chaque 20 sec, et la réponse électromyographique de l'adducteur du pouce enregistrée. L'installation de 50% du bloc neuromusculaire, tel que démontré par électromyographie, fut plus courte dans le groupe césarienne (80 ± 30 sec) que le groupe contrôle (144 ± 43 sec). Les conditions d'intubation à 50% de bloc furent adéquates dans les deux groupes. Aussi, l'installation d'un bloc à 90% était plus court dans le groupe césarienne. Le temps de récupération pour un rapport T_1/contrôle de 25% était plus long pour le groupe césarienne (46 ± 10 min) que le groupe contrôle (28 ± 10 min). Les résultats démontrent que l'administration de vécuronium selon le poids amène une installation du bloc neuromusculaire plus rapide et une récupération plus tardive chez les patients devant subir une césarienne que celles non gravides du groupe contrôle.

Key words
ANAESTHESIA: obstetrical;
ANAESTHETIC TECHNIQUES: induction;
NEUROMUSCULAR RELAXANTS: vecuronium.

From the Departments of Anesthesiology, Obstetrics & Gynaecology, and Epidemiology and Biostatistics, American University of Beirut, Beirut, Lebanon.

Address correspondence to: Dr. Anis Baraka, Professor and Chairman, Department of Anesthesiology, American University of Beirut, Beirut, Lebanon.

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Vecuronium has been suggested for rapid-sequence induction of anaesthesia in patients undergoing Caesarean section.[1] Also, ketamine has been used for induction of anaesthesia for Caesarean section.[2] The present report investigated the onset of neuromuscular blockade and the conditions for tracheal intubation when a ketamine-vecuronium sequence was used for rapid-sequence induction in patients scheduled for elective Caesarean section. The results were compared with that achieved when the same sequence was used in a control group of nonpregnant women.

Methods

The investigation was approved by the Institution Research Committee and informed consent was obtained. Ten full-term pateints undergoing elective Caesarean

section were investigated; their mean age was 30 ± 6 yr and mean body weight 75 ± 11 kg. The control group of ten nonpregnant women were aged 28 ± 8 yr and weighed 58 ±9 kg, who were scheduled for gynaecological procedures such as laparoscopy and tubal ligation.

All patients received premedication with atropine 0.6 mg *im.* In the operating room, patients were monitored with ECG, non-invasive blood pressure measurement (Omega 1400), and pulse oximeter (Radiometer Copenhagen). An intravenous infusion of lactated Ringer's solution was started on the dorsum of the left hand, and neuromuscular transmission was monitored in the right hand.

Neuromuscular monitoring

Neuromuscular transmission was monitored with a Datex Relaxograph® monitor. The ulnar nerve was stimulated supramaximally at the wrist every 20 sec, with train-of-four stimuli at a frequency of 2 Hz and the electromyographic response of the adductor pollicis was displayed. Electromyographic monitoring started in the awake patient during the preoxygenation period, and was continued during induction of anaesthesia and throughout the surgical procedure.

When a steady electromyographic response was displayed, anaesthesia was induced using a rapid-sequence technique in both the Caesarean and control groups. Following preoxygenation by a face mask with five litres of 100% oxygen for three to five minutes, anaesthesia was induced with ketamine 1.5 $mg \cdot kg^{-1}$. After 40–60 sec, when sleep was induced, vecuronium 100 $\mu g \cdot kg^{-1}$ was injected intravenously. The times between the completion of the injection of vecuronium and the development of T_1/control ratio of 50% and 10% were recorded, and were considered as the onset times to 50% and 90% neuromuscular block respectively. The onset times in the Caesarean group were compared with that achieved in the control nonpregnant groups of patients. Also, the time of recovery to T_1/control ratio of 25% was compared in the two groups.

Conditions of tracheal intubation

Laryngoscopy was performed in all patients at 50% neuromuscular block, and conditions for tracheal intubation were scored according to Table I as excellent, good, fair, or poor. Tracheal intubation was performed when the score was excellent or good, and was not done when the score was fair or poor. In the latter conditions, intubation was performed at 90% neuromuscular block.

Administration of oxygen by face mask, without assisting ventilation, was continued throughout the period of induction until the trachea was intubated. Following tracheal intubation, the lungs of patients undergoing Caesarean section were ventilated with 100% oxygen until delivery of the fetus. After delivery, anaesthesia was maintained with nitrous oxide:oxygen mixture (2:1), supplemented with fentanyl 3 $\mu g \cdot kg^{-1}$. In the nonpregnant control patients, nitrous oxide:oxygen administration started after tracheal intubation. At the end of surgery, which lasted 30–60 min, neuromuscular blockade was reversed in both groups with a mixture of atropine 0.02 $mg \cdot kg^{-1}$ and neostigmine 0.05 $mg \cdot kg^{-1}$.

All data other than intubation scores are reported as mean ± standard deviation (SD), and Student's t test was used to compare data. Chi-square was used to compare the intubation scores. $P < 0.05$ was considered significant.

TABLE I Intubation scores

Score	*Jaw*	*Vocal cords*	*Diaphragmatic movement*
Excellent	Relaxed	Abducted and immobile	Absent
Good	Relaxed	Abducted and immobile	Slight "bucking"
Fair	Relaxed	Moving	"Bucking"
Poor	Not relaxed	Closed	"Bucking"

TABLE II Onset time to 50% and 90% neuromuscular block (NMB), and time to 25% recovery

	Caesarean group	*Control group*
Onset time (sec)		
50% NMB	80 ± 30	144 ± 43
90% NMB	125 ± 66	288 ± 163
Recovery to 25% (min)	46 ± 10	28 ± 10

Results

Onset of neuromuscular block

The mean onset times to 50% and 90% neuromuscular block are shown in Table II. In patients undergoing Caesarean section, the onset time was shorter than that observed in the control nonpregnant women ($P < 0.05$). Recovery of T_1/control ratio of 25% was longer in the pregnant patients (46 ± 10 min) than in the nonpregnant patients (28 ± 10) ($P < 0.05$).

Intubation scores

The conditions for tracheal intubation at 50% neuromuscular block in both groups were excellent or good in 90% of the patients, and in only one patient in each group was the trachea not intubated (Table III). The tracheas which were not intubated at 50% neuromuscular block could be easily intubated at 90% block. In all patients, oxygen

TABLE III Intubation scores as assessed during laryngoscopy and 50% neuromuscular block

Intubation score	*Caesarean group*	*Control group*
Excellent	7	9
Good	2	0
Fair	1	1
Poor	0	0

saturation as monitored by pulse oximetry ranged between 98% and 100% during the induction-intubation interval.

Discussion

The present report shows that the onset of vecuronium neuromuscular block is more rapid in patients undergoing Caesarean section than in nonpregnant women. The rapid onset of block in the pregnant patient may be attributed to the increased cardiac output. During pregnancy, the cardiac output increases by about 35% by the eighth week of gestation, and may remain elevated to term,[3] unless decreased by the supine hypotensive syndrome.[4] Also, the blood flow to most organs including the limbs increases during pregnancy by decreasing the peripheral resistance to accommodate the increased cardiac output.[5] Blood flow appears to be a determinant factor which speeds the onset of neuromuscular block.[6,7] During pregnancy, blood flow is increased, while blood protein concentrations are decreased[8] with a possible decrease of protein binding of vecuronium, thereby increasing the amount of free drug delivered to the site of action.

The rapid onset of neuromuscular block in the pregnant women may also be attributed to a relative overdose when vecuronium is administered according to body weight. Vecuronium, in common with other muscle relaxants, does not cross the placental barrier to reach the fetus in clinically important concentrations.[9] Also, vecuronium may not readily redistribute to the fat which has accumulated and the water which is retained during pregnancy and which partially contribute to the increased body weight of the parturient. The mean weight of our patients undergoing Caesarean section was higher than the mean body weight of the control nonpregnant group. Similar to the obese patient,[10] administration of vecuronium according to body weight represents a relative overdose. Our present report showed that recovery of T_1/control ratio to 25% was longer in the pregnant than in the nonpregnant control group of patients. Previous investigations have shown that patients undergoing Caesarean section require on a weight basis, smaller doses of vecuronium than normal, to maintain muscle relaxation[11] and the increased response to vecuronium has been observed also in postpartum patients within one to four days after delivery.[12,13]

Although the onset of 50% and 90% vecuronium neuromuscular block was more rapid in the pregnant patients, tracheal intubation could be readily achieved in both groups at 50% vecuronium block when a ketamine-vecuronium sequence was used for induction of anaesthesia. Central well-perfused muscles of the upper airway may be totally blocked when the adductor pollicis is only 50% blocked.[14] Also, ketamine induction may obtund the airway reflexes. Previous reports have also shown that ketamine induction better attenuates the haemodynamic response to laryngoscopy and intubation than thiopentone[15] and can decrease the incidence of bronchospasm.[16,17]

Because of the rapid onset of 50% block in the parturient, ketamine-vecuronium may be considered as an alternative technique for rapid-sequence intubation in patients undergoing Caesarean section, without the need for "priming"[18,19] or "high-dose" techniques.[20] The "priming" technique has some risks which include the distressing sensation of dyspnoea, respiratory impairment, and possible aspiration of gastric contents.[21] The "high-dose" technique, although it decreases the onset time, prolongs the duration of neuromuscular block which may exceed the operative time.[20] Succinylcholine, when not contraindicated, remains the muscle relaxant of choice in situations – including Caesarean section – where a rapid-sequence induction of anaesthesia is indicated.[22,23]

In conclusion, the present report shows that the mean onset time to 50% and 90% neuromuscular block following ketamine-vecuronium sequence is shorter in patients undergoing Caesarean section than in nonpregnant women of the same age, and that tracheal intubation can be easily performed at 50% neuromuscular blockade. The time of recovery to T_1/control ratio of 25% is longer in the Caesarean group. The results suggest that administration of vecuronium according to body weight results in a more rapid onset of neuromuscular block and delayed recovery in the pregnant women undergoing Caesarean section than in the nonpregnant control patients.

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