

## OBSTETRICS

### Case series

# Sugammadex reversal of rocuronium-induced neuromuscular block in Caesarean section patients: a series of seven cases

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### Key points

- Neuromuscular block can be prolonged in pregnancy.
- Rocuronium can be used for rapid-sequence induction in Caesarean section patients.
- Sugammadex was used to reverse block in seven patients after Caesarean section.
- Reversal was achieved promptly in all seven with a dose similar to that for non-pregnant patients.

Sugammadex is a selective relaxant-binding agent, which reverses rocuronium-induced neuromuscular blocks of any depth by chemical encapsulation of rocuronium in the plasma in various groups of patients. We reported seven Caesarean section cases, undergoing general anaesthesia with thiopental (6 mg kg<sup>-1</sup>) and rocuronium (0.6 mg kg<sup>-1</sup>) who were given desflurane and fentanyl for maintenance of anaesthesia after delivery. The action of rocuronium may be prolonged in pregnant women. At the end of the operation, all patients had a significant degree of neuromuscular block. In five patients, there was no single twitch response and no TOF ratio, one patient had one twitch detectable, and in one patient, a TOF ratio of 3% was detected. The recommended dose of sugammadex for reversal of profound block (4 mg kg<sup>-1</sup>) or moderate block (2 mg kg<sup>-1</sup>) was given. In all patients, sugammadex provided rapid and sufficient reversal to TOF >0.9 within 2 min. All patients were monitored after operation, and no signs of recurarization occurred in any patient and no signs of neuromuscular weakness were observed.

**Keywords:** anaesthesia; Caesarean section; reversal; rocuronium; sugammadex

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Sugammadex, a modified  $\gamma$ -cyclodextrin, is a selective relaxant-binding agent, which has been developed to induce rapid recovery after rocuronium-induced neuromuscular block.<sup>1</sup> The sugammadex-rocuronium interaction reduces the amount of free rocuronium in plasma and leads to a shift of rocuronium into the plasma, reducing the level of rocuronium at the neuromuscular junction dramatically.<sup>2</sup> Thus, a fast liberation of acetylcholine receptors occurs, and immediate reappearance of muscle activity takes place.

Rocuronium has been shown to be a valuable alternative to provide fast tracheal intubation.<sup>3–4</sup> Nevertheless, in Caesarean section patients, it is evident that the duration of action of amino-steroidal neuromuscular blocking agents is prolonged.<sup>5–7</sup> In this specific group of patients, it has been shown that rocuronium 0.6 mg kg<sup>-1</sup> provides, in the presence of a sufficient dose of thiopental (6 mg kg<sup>-1</sup>), clinically acceptable intubating conditions in 90% of patients.<sup>8</sup>

Sugammadex has been shown to provide a rapid and sustained reversal (TOF <0.9) of rocuronium at various doses (0.6, 1.0, and 1.2 mg kg<sup>-1</sup>).<sup>9–11</sup> However, the use of

sugammadex to reverse rocuronium block in Caesarean section patients has not been described.

Rocuronium is approved in Germany for the use in Caesarean section and, in our institution, is often used instead of succinylcholine. Sugammadex is approved in our hospital for reversal of profound neuromuscular block at the end of operations to avoid prolonged wake-up times and postoperative ventilation. We report on seven patients undergoing Caesarean section under general anaesthesia which included rocuronium in whom neuromuscular block was successfully antagonized with sugammadex at different levels of neuromuscular block.

### Case reports

In all cases, anaesthesia was conducted according to our standard operating procedures. Preoxygenation achieved an end-tidal O<sub>2</sub> concentration of >85% before induction of anaesthesia. Anaesthesia was induced with thiopental and rocuronium (Table 1). In all patients, the trachea was intubated 60 s after rocuronium administration. Neuromuscular

**Table 1** Physical characteristics, dose regimen of anaesthetic agents, and recovery data

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6	Patient 7
Age (yr)	29	28	33	26	36	30	39
Weight (kg)	75	103	73	56	92	75	70
Height (cm)	160	170	174	153	173	168	170
ASA class	III	II	II	II	II	II	I
Gestation (weeks)	38	39	38	40	39	38	26
Thiopental (mg kg <sup>-1</sup> )	5.4	5.0	5.4	7.0	5.4	5.5	5.0
Rocuronium (mg kg <sup>-1</sup> )	0.66	0.50	0.66	0.66	0.66	0.66	0.57
Duration of operation (min)	28	53	25	20	38	28	35
TOF value at end of operation (%)	0	3	0	0	0, T <sub>2</sub>	0	0
Sugammadex (mg kg <sup>-1</sup> )	4	2	3	4	2	4	4
Time to TOF >0.9 (s)	60	50	90	60	60	50	100

function was monitored at the adductor pollicis muscle using the continuous TOF mode of the NMT module (Datex, Helsinki, Finland) or TOF-watch monitor (Schering-Plough, Oss, The Netherlands). After delivery, anaesthesia was maintained with desflurane (4–5% end-tidal) and fentanyl (0.3–0.45 mg). At the end of the operation, sugammadex was given, and once full recovery (TOF >0.9) occurred, desflurane was discontinued and the patient extubated when awake. In all cases, live children were born, and the paediatricians observed no signs of neuromuscular weakness in any of them. After operation, the patients were monitored for 3 h for recurarization. No signs of muscle weakness or recurarization were observed in any of them.

**Case 1**

A 30-yr-old woman (75 kg, 160 cm, ASA II), at 39 weeks of gestation, with a medical history of allergic asthma, was undergoing elective Caesarean section at her request. The operation lasted 28 min, and no twitches or TOF ratio was detectable at the end of surgery. Sugammadex 300 mg (4 mg kg<sup>-1</sup>) was given, and within 30 s, the TOF recovered to 79% and at 60 s to 95%.

**Case 2**

A 28-yr-old woman (103 kg, 170 cm, ASA II), at 39 weeks of gestation in breech presentation, with no medical history, had an elective Caesarean section and sterilization. The operation lasted for 53 min. At the end of surgery, a TOF ratio of 3% was detectable and we administered sugammadex 200 mg (2 mg kg<sup>-1</sup>). Within 30 s, the TOF recovered to 86% and at 50 s to 100%.

**Case 3**

A 33-yr-old woman (73 kg, 174 cm, ASA I), pregnant at term, without any medical history, had an elective Caesarean section at her request with general anaesthesia. The operation lasted 25 min, and no twitches or TOF ratio was detectable, at the end of surgery. Sugammadex 200 mg (3 mg kg<sup>-1</sup>) resulted in recovery of TOF to 76% within 50 s and to 94% at 90 s.

**Case 4**

A 26-yr-old woman (56 kg, 153 cm, ASA II), pregnant at term, with no medical history, had an elective Caesarean section. The operation lasted 20 min, and no twitches or TOF ratio was detectable, at the end of surgery. Sugammadex 200 mg (4 mg kg<sup>-1</sup>) was given, and within 50 s, the TOF was 93% and at 60 s, 97%.

**Case 5**

A 36-yr-old woman (92 kg, 173 cm, ASA II), pregnant at term, with no medical history, had an elective Caesarean section. The operation lasted 38 min and two twitches but no TOF ratio was detectable, at the end of surgery. Sugammadex 200 mg (2 mg kg<sup>-1</sup>) was given for this shallow block, and TOF recovered to 67% at 30 s and 93% at 60 s.

**Case 6**

A 30-yr-old woman (75 kg, 168 cm, ASA II), pregnant at term, with no medical history, requested a Caesarean section with general anaesthesia. The operation lasted for 28 min, and no twitches or TOF ratio was detectable, at the end of surgery. Sugammadex 300 mg (4 mg kg<sup>-1</sup>) was given, and within 30 s, TOF recovered to 78% and at 50 s to 98%.

**Case 7**

A 40-yr-old woman (70 kg, 170 cm), with no medical history, presented for emergency Caesarean section due to premature rupture of the membranes gestation at 26 weeks. The operation lasted for 40 min, and no twitches or TOF ratio was detectable, at the end of surgery. Sugammadex 200 mg (4 mg kg<sup>-1</sup>) was given, and within 60 s, the TOF recovered to 73% and at 80 s to 94%.

**Discussion**

This case series of reversal of rocuronium neuromuscular block after Caesarean section shows that sugammadex, in the recommended doses of 2 mg kg<sup>-1</sup> for moderate block and 4 mg kg<sup>-1</sup> for profound block, has the same efficacy as shown in other groups of patients.<sup>9 10 12</sup> The prolonged

action of amino-steroidal neuromuscular blocking agents in pregnant and post-partum patients has been attributed to a delayed metabolism or elimination through the liver.<sup>5–7</sup> The encapsulating action of sugammadex removes rocuronium from the postsynaptic receptors allowing normal function.<sup>2, 13</sup> Thus, sugammadex makes changes in metabolism or elimination of rocuronium much less important. Our findings are consistent with others previously observed in groups of patients with altered clearance of rocuronium.<sup>14</sup>

For rapid-sequence induction of anaesthesia, an increased dose of rocuronium (1.0 mg kg<sup>-1</sup>) is recommended to achieve intubating conditions at 60 s comparable with those found with succinylcholine.<sup>15</sup> It has been shown in Caesarean section patients that rocuronium (0.6 mg kg<sup>-1</sup>) provides clinically acceptable intubating conditions, when a sufficient dose of thiopental (6.0 mg kg<sup>-1</sup>) for induction is also given.<sup>8</sup> The more rapid onset of rocuronium was attributed to the higher cardiac index in pregnant patients. In addition, the prolonged action of rocuronium in pregnant and post-partum patients (25%) would support the use of the usual intubating dose of rocuronium (0.6 mg kg<sup>-1</sup>) for Caesarean section patients.<sup>7</sup>

Anticholinesterases, such as neostigmine, may fail to reverse profound neuromuscular block<sup>16</sup> and persistent neuromuscular block in pregnant and post-partum patients.<sup>5–7</sup> This is due to their action of competitive inhibition of the breakdown of acetylcholine, thus increasing the acetylcholine level in the neuromuscular junction, rather than a direct action on the neuromuscular blocking drug. Additionally, they do not increase the total amount of acetylcholine molecules in the synaptic cleft at all. It has been shown that there is a ceiling effect after administration of neostigmine, and if neostigmine is administered before partial spontaneous recovery has returned, the time to achieve a TOF ratio of >0.9 cannot be shortened.<sup>17</sup>

The recovery times we observed are similar to those found previously for sugammadex given for profound (deep) block at different time points (3, 5, or 15 min) after rocuronium (0.6 mg kg<sup>-1</sup>).<sup>9</sup> The speed of recovery was dose-dependent, and the reversal was sustained without any signs of recurarization, which agrees with our findings. The mean recovery time to a TOF ratio of 0.9 when sugammadex 4 mg kg<sup>-1</sup> was given 15 min after rocuronium (0.6 mg kg<sup>-1</sup>) was 2.1±1.2 min.<sup>9</sup> Sugammadex (2 mg kg<sup>-1</sup>) given at moderate (shallow) rocuronium-induced block had a recovery time of 1.8±0.7 min,<sup>10</sup> which also agrees with our findings.

Sugammadex provided a rapid reversal to TOF >0.9 after rocuronium-induced neuromuscular block in Caesarean section patients. The recommended doses of sugammadex, 2.0 mg kg<sup>-1</sup> for reversal of moderate (shallow) block and 4.0 mg kg<sup>-1</sup> for profound (deep) block, were effective and reliable in Caesarean section. No adverse effects related to sugammadex or evidence of recurarization were observed in any patient.

## Conflict of interest

FKP and CR have previously received research grants and honoraria for studies and lectures from Shering-Plough. No funding or grant was received for this Case report. FKP is a member of the German advisory board of Shering Plough.

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