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Incidence, causes and complications of general anesthesia for cesarean section : a 9-year retrospective analysis of a large tertiary centre

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Abstract : *Background :* Aspiration during or after general anesthesia for cesarean section is an important cause of maternal and fetal morbidity and mortality. Nowadays, regional anesthesia is considered as the gold standard for labor analgesia and cesarean sections. In this retrospective analysis, we were interested in the incidence, indications and complications related to general anesthesia. Identifying these causes can reduce the need for general anesthesia and the potentially associated maternal morbidity and mortality related to failed intubation and/or aspiration.

Methods : Each obstetrical case where an anesthesiologist had been involved was registered in a database, which contained the medical history of the patient, the characteristics of the actual and previous pregnancies, and the details of the anesthesia technique that was used in the past.

Results : One hundred and two out of the 5269 cesarean sections were performed under general anesthesia (1.9%). Fifty % were necessary because of fetal or maternal distress, 22% due to failure of regional anesthesia, 25% because of coagulation problems, and 7% due to back problems. One % refused regional anesthesia. There were no major complications.

Discussion : Fetal and maternal distress are the most important reasons for failure of regional anesthesia. The conversion rate from regional to general anesthesia for emergency cesarean sections was 0.3%.

Conclusions : Maternal or fetal distress is the most important cause of general anesthesia, followed by coagulation disorders, failed regional anesthesia, back problems and refusal of the patient. No major complications occurred.

2012, only 3 cases of maternal death from aspiration have been reported in the United Kingdom. It is estimated that aspiration is the cause of maternal death in less than 1 in 4.5 million deliveries (11). In the United States, prior to 1990, aspiration was the most common cause of anesthesia-related maternal mortality. The relative risk of maternal mortality following general anesthesia was 17 compared to regional anesthesia and this ratio decreased to 1.7 in 2002 (9).

In the "Serious Complications Related to Obstetric Anesthesia" (SCORE) project of the "Society for Obstetric Anesthesia and Perinatology" (SOAP), no case of aspiration has been reported in 257.000 procedures including 5000 general anesthesia cases between 2004 and 2009.

The decrease in this complication is related to the increased use of regional anesthesia, antacids, anti-H₂ or proton pump inhibitors, rapid sequence induction for general anesthesia, and a better training in anesthesia providers. Concerning failed intubation, the recent SCORE project of the SOAP reported an incidence of failed intubation of 1 in 533 (12).

The last "Mothers and Babies- Reducing Risk through Audits and Confidential Enquiries across the UK" (MBBRACE-UK) Survey reported no maternal deaths related to failed intubation (11). Adverse events related to general anesthesia remain more frequent than post regional anesthesia and

BACKGROUND

Aspiration during or after general anesthesia for cesarean section is an important cause of maternal and fetal morbidity and mortality (1). While cricoid pressure was developed to reduce the mortality due to aspiration pneumonia (2-4), failed intubation caused by cricoid pressure (incidence 1/300) (5) resulted in an even greater mortality (6-8). During the last decades, maternal mortality rates and the incidence of aspiration and failed intubation have decreased immensely (9, 10). Between 1994 and

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maternal mortality is still twice as high after general anesthesia (13). For these reasons, it's strongly recommended to use regional anesthesia for cesarean sections (14-17). In addition, the majority of women wish to be awake during the cesarean section. Currently, regional anesthesia is considered the gold standard for labor analgesia and cesarean sections (18). However, regional anesthesia is sometimes impossible to perform or fails, so general anesthesia is occasionally indicated.

In addition, the effects of anesthetic agents on the fetus was one of the main reasons to avoid general anesthesia in cesarean delivery. Hypnotic drugs affect the fetus through utero-placental transfer and can lead to neonatal depression. They provoke hypotension, which leads to a reduced blood flow to the placenta, fetal bradycardia and acidosis (19). Because opioids depress the ventilation of the fetus, they are only given after delivery (20). In addition, anesthetic agents have an effect on neuronal receptors that play a role in neuronal differentiation, synaptogenesis and survival during development, which takes place from mid-gestation to several years after birth. It has been suggested that anesthesia-induced GABA_A receptor activation and NMDA- receptor blockade during this critical stage in brain development lead to depression of neuronal activity, which initiates the apoptotic cell death cascade in immature neurons (22).

We investigated all cases performed under general anesthesia (failure of regional anesthesia and other causes) during a 9-year period in our center, and tried to identify the reasons for and complications related to general anesthesia. Our aim was to identify if general anesthesia was avoidable, thus reducing the need for general anesthesia and potentially associated maternal morbidity and mortality related to failed intubation and /or aspiration.

Our primary hypothesis was that maternal or fetal distress was the most important cause for general anesthesia. Secondary hypotheses were that general anesthesia for cesarean section was associated with a certain complication rate, like difficult intubation and aspiration.

METHODS

We used a STROBE checklist for this retrospective analysis (23). Data related to anesthesia technique and patient characteristics were extracted from an electronic database for any parturient who delivered between 01.01.2007 and 31.12.2015 in the University Hospitals of Leuven, a large tertiary center in Belgium. Data were collected in March 2016.

Each obstetric case where an anesthesiologist had been involved was registered in a database. This database contains the medical history of the patient, the characteristics of the actual and previous pregnancies, and the details of the anesthesia technique that was used in the past. When general anesthesia was used, information regarding the reason, the medication, the grade of intubation [Cormack- Lehane classification system (24)] and the presence of aspiration was noted. The medical file of the patient contained the reports on the consultations of the obstetrician and anesthesiologist.

The grade of emergency of a cesarean section is divided in 4 categories (Table 1) according to the Royal College of Obstetricians (25). Table 2 shows the standard protocol at the University Hospitals of Leuven for analgesia during labor and a cesarean section, according to the guidelines of the American Society of Anesthesiologists Task Force on Obstetric Anesthesia and the Society for Obstetric Anesthesia and Perinatology (26).

The primary outcome was defined as the indications of general anesthesia for cesarean section. Secondary outcomes were the modalities and the complications of general anesthesia.

RESULTS

a) Primary Outcome : the indications for general anesthesia for cesarean sections.

Table 3 shows the total number of births per year, with the number of cesarean sections and the amount of cesarean sections under regional and

Table 1

Classification of urgency of cesarean section, according to the Royal College of Obstetricians

Code	Definition
1	Maternal or fetal compromise, with immediate threat to life for woman or fetus
2	Maternal or fetal compromise, without immediate threat to life for woman or fetus
3	No maternal or fetal compromise, but early delivery required
4	No maternal or fetal compromise, at a time to suit woman and maternity services

Table 2

Standard protocol at the University Hospitals of Leuven for analgesia during labour and cesarean sections.
CSE: Combined spinal epidural analgesia, PCEA : Patient controlled epidural analgesia, cont. : Continuous rate, IV: intravenous

Labor
CSE L3-4, L4-5 Ropivacaine 0,120% +Sufentanil 0,75µg/mL 4-4,5mL Followed by PCEA Bolus 4mL Ropivacaine 0,120% +Sufentanil 0,75µg/mL, lock- out 15min, cont rate 2mL
Cesarean section- Code 1- No epidural catheter in situ
Aspiration prophylaxis* Left lateral tilt position Preoxygenation: 100% oxygen by mask, 3-8 deep breaths Obstetrician ready to start surgery Remifentanyl 0,25mg/kg IV, followed by a continuous infusion of 0,25-0,5mg/kg/min Cricoid Pressure, no ventilation Propofol TCI 5-6mg/mL IV Succinylcholine 1,5mg/kg IV
Cesarean section- Code 1-4- Epidural catheter in situ
Chloroprocaine 3%: titrate 5-8-7cc epidural till block T2 Aspiration prophylaxis*
Cesarean section- Code 2-3-4- No epidural catheter in situ
CSE L3-4, L4-5 Hyperbaric Bupivacaine 0,5% 1,5mL +Sufentanil 2.5µg/0,5mL Aspiration prophylaxis*
High risk vaginal delivery (Twins, breech, previous section)
Catheter early in labour Anesthetist present during full disclosure 3- 5mL Ropivacaine 0,120% +Sufentanil 0,75µg/mL epidural during delivery
*Aspiration prophylaxis
histamine 2 receptor antagonist (Ranitidine 50mg IV) + gastro- prokinetic (Primperan 10mg IV) + non- particulate antacid (Sodium Citrate 0,3M 30mL PO)

Table 3

The number of births per year between 2007 and 2015, with the total number of cesarean sections (% between parentheses) and the number performed under regional and general anesthesia in our hospital. RA : Regional anesthesia, GA : General anesthesia.

Year	Births	RA	Section (%)	Section RA	Section GA (%)
2007	2160	1647	547 (25.3)	539 (98.5)	8 (1.5)
2008	2236	1668	522 (23.3)	512 (98.1)	10 (1.9)
2009	2304	1812	593 (25.7)	579 (97.6)	14 (2.4)
2010	2228	1821	650 (29.2)	636 (97.8)	14 (2.2)
2011	2266	1822	591 (26.5)	580 (98.1)	11 (1.9)
2012	2386	1905	641 (26.9)	630 (98.2)	11 (1.8)
2013	2335	1919	596 (25.5)	586 (98.3)	10 (1.7)
2014	2386	1952	660 (27.7)	649 (98.3)	12 (1.7)
2015	2237	1516	469 (21.0)	457 (97.4)	12 (2.6)
TOTAL	20538	16062 (78.2%)	5269 (25.7%)	5168 (98.1%)	102 (1.9%)

general anesthesia in our hospital between 2007 and 2015. There were 20538 births, of which 5269 (25.7%) occurred through a cesarean section. One hundred and two (1.9%) were performed under

general anesthesia, and 5168 (98.1%) under regional anesthesia. Of the 102 patients, 69 (67.6%) had no or minor medical problems (ASA1-2), 33 (32.4%) were ASA3 patients. There was no missing data.

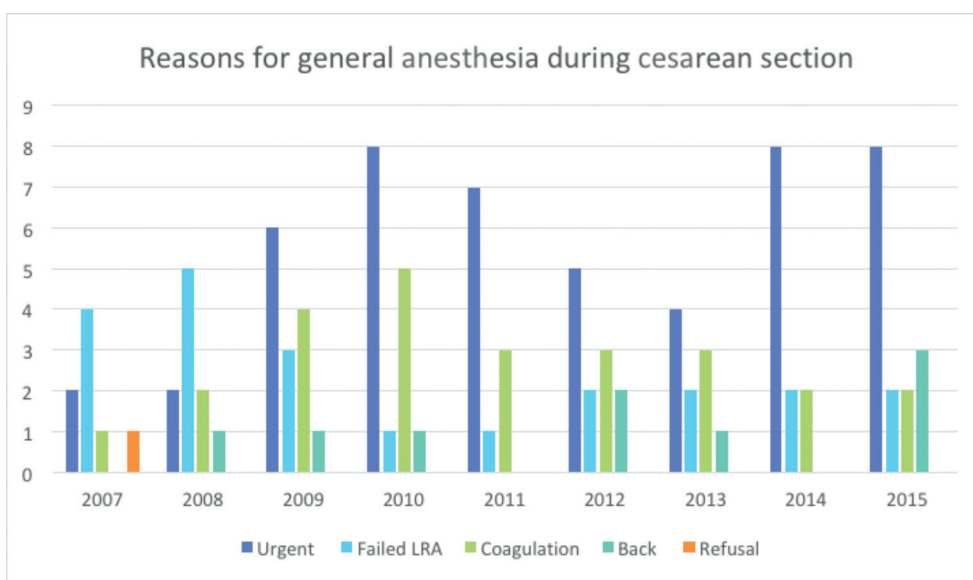


Fig. 1 — Indications for general anesthesia for cesarean sections in our hospital between 2007 and 2015. We distinguish urgent (maternal or fetal compromise), failed regional anesthesia, refusal of the patient, coagulation and back problems as main reasons for failure of regional anesthesia. LRA : Regional anesthesia.

Figure 1 gives an overview of the reasons for general anesthesia for cesarean section in our hospital.

Maternal or fetal compromise

Fifty % of the cesarean sections that were performed under general anesthesia were necessary due to fetal or maternal compromise (Table 1, code 1). Twelve of these were caused by an abruptio placenta, 4 because of a rupture of the uterus, 6 due to an umbilical cord prolapse, and 1 because of a nuchal cord. In 17 cases, the first cardiotocography (CTG) at the moment of arrival in the hospital showed fetal bradycardia or asystole. In 4 cases concerning twins, a cesarean section was necessary because of bradycardia of the second fetus, after delivery of the first one.

There were 6 emergency cesarean sections due to maternal compromise. Two of these mothers were in septic shock when they arrived in the hospital (one due to an acute pancreatitis, another caused by an infection of the uterus). One patient developed an anaphylactic shock with hypotension and a negative impact on the CTG after the intravenous administration of amoxicilline.

Three cases concerning patients diagnosed with a placenta praevia and percreta were well prepared preoperatively to receive a regional anesthesia but turned out into a general anesthesia because of an important blood loss. Another woman diagnosed with eclampsia developed a tonic-clonic seizure at

33 weeks of pregnancy. Intubation was necessary, followed by emergency cesarean section.

Failed regional puncture

Twenty two women (22%) received a general anesthesia because of failure of the regional anesthesia. In 3 of these cases, the supervisor with certified board exam failed also after multiple punctures. In 11 of these 22 settings, the supervisor was called, but there was no time for more than 1 or 2 punctures (code 2). Four women had a good surgical block but weren't comfortable and needed a general anesthesia. Four patients already had an epidural catheter for labor, but the epidural wasn't working anymore due to dislocation of the catheter (2 patients) or the lack of time to wait for a surgical block (2 patients).

Coagulation problems

Twenty-six patients (26%) needed a general anesthesia because of coagulation problems (Table 4).

For the patients with a hereditary bleeding disorder, the specialist of bleeding and coagulation disorders decided that a general anesthesia was necessary, because of the risk of an epidural hematoma in case of regional anesthesia. These cases were well prepared, aspiration prophylaxis was administered and a supervisor of anesthesia was present at induction. Concerning the two

Table 4

Causes of coagulation disorders in pregnancy.

HELPP : Haemolysis Elevated liver enzymes and low platelets, + : present, - absent.

Disorder	Weeks of pregnancy at birth	Bad coagulation on arrival	Preoperative consultation
HELPP	27	?	-
HELPP	30	?	-
HELPP	31	+	-
HELPP	25	+	-
HELPP	36	+	+
HELPP + abruptio placentae	38	+	-
HELPP + pre-eclampsia	26	+	-
HELPP + pre-eclampsia	24	+	-
HELPP + pre-eclampsia	26	+	-
Preeclampsia	30	+	-
Eclampsia	33	+	-
Acute fatty liver	38	+	-
Gestational thrombocytopenia	41	+	-
Severe bleeding placenta accreta	28	+	-
Increased risk of thrombosis			
Antiphospholipid syndrome +preeclampsia	34	+	+
Pulmonary embolism + preeclampsia	25	+	-
Deep venous thrombosis	28	+	-
Protein S deficiency +abruptio placentae	31	+	-
Hereditary bleeding diathesis			
Von Willebrand	37	+	+
Von Willebrand	38	+	+
Von Willebrand	39	+	+
Von Willebrand	40	+	+
Factor VII deficiency	39	+	+
Fontan	34	+	+
Fontan	35	+	+

patients with the Fontan circulation, there was a multidisciplinary consultation with the obstetrician, anesthesiologist and cardiologist. In these cases, we decided to perform the combined spinal epidural 6 hours after stopping the heparin infusion and normalization of the activated partial thromboplastin time. Table 4 shows that these 2 patients arrived at the hospital in preterm labor: one patient with the Fontan circulation needed a cesarean section because of a poor CTG, another because of breech position. Because the heparin infusion wasn't stopped, they needed a cesarean section under general anesthesia.

For the patients with an increased risk of thrombosis, we decided after a multidisciplinary consultation with the specialist of bleeding and coagulation disorders to stop anticoagulation at the time and place the epidural after the recommended waiting time. These 4 patients arrived at the hospital with preterm labor combined with a bad CTG, so anticoagulation wasn't stopped and regional

anesthesia was contraindicated. The incidence of prematurity in this group was high: 10 fetuses were born before 30 weeks of pregnancy, 7 between 31 and 35 weeks of pregnancy, and 7 between 35 and 40 weeks.

Back problems

In 3 patients with spina bifida, 2 with a fusion of their scoliosis, 1 with an urgent paraparesis due to a T3-4 mass on MRI and 1 with a multiple synostosis syndrome, we decided together with the patient that general anesthesia was the safest option in case of a cesarean section.

Patient refusal

Patient refusal is an absolute contraindication for regional anesthesia. During the 9 years, there was only one patient who refused regional anesthesia.

b) Secondary outcome : Modalities of general anesthesia

All 102 patients got a rapid sequence induction. Different medications were used (Table 5). Cricoid pressure was performed in 52 patients (50%). Aspiration prophylaxis was administered in 26 patients before induction of anesthesia, and in 3 patients during the cesarean section.

Twenty of the 102 patients (20%) who received general anesthesia for the cesarean section were preoperatively seen at the consultation of anesthesia. These were 10 patients with a known coagulation disorder, 7 with back problems, 2 with a diagnosed placenta percreta, and the patient who refused the regional anesthesia.

Table 5

Induction agents used for general anesthesia for cesarean section in our hospital between 2007 and 2015.

Opioid	Remifentanyl	88
	Fentanyl	4
	Sufentanyl	13
Hypnotic	Propofol (continuous infusion)	102
	Ketamine	5
	Propofol bolus followed by Sevoflurane	3
Curare	Succinylcholine	96
	Rocuronium	6

c) Secondary Outcome : Complications of general anesthesia

In 5 cases (5%), intubation was difficult (Cormack 2 and 3), but intubation was possible by releasing the cricoid pressure. One intubation of a planned general anesthesia was performed with a video-laryngoscope. No intubation was impossible. No aspirations occurred. No cases of awareness were reported.

DISCUSSION

Between 2007 and 2015, 102 of the 5269 cesarean sections were performed under general anesthesia (1.9%). Fifty % were necessary because of fetal or maternal distress, 22% due to failure of regional anesthesia, 25% because of coagulation problems and 7% due to back problems. One patient refused regional anesthesia. In 5 cases (5%), intubation was difficult. There were no aspirations.

A cesarean section under general anesthesia is a stressful situation, where the focus of the anesthesiologist should be completely on the patient, and not on the writing of the anesthesia report, which was a handwritten document from 2007 till

2015. Therefore, these anesthesia reports are filled in retrospectively. This can lead to inadequate reporting. Aspiration prophylaxis is prepared and administered by the midwife in case of an urgent cesarean section. Residents are supposed to control if these medicaments were given. Every rapid sequence induction is performed with a cricoid pressure. Therefore, we believe that the number of aspiration prophylaxis that were administered and cricoid pressures that were performed, are lower than in reality, due to charting errors.

One can see that the number of cesarean sections under general anesthesia remained constant between 2007 and 2015 (Table 3). This is in contrast with the literature, where they state that general anesthesia for cesarean section is still decreasing in incidence (13, 27). The number of cesarean sections slightly increased in our hospital, while it is decreasing in some other European countries (13). Reasons are the presence of a neonatal intensive care unit, which attracts high risk pregnancies and prematurity's, with an increased risk for cesarean sections (28). We see that maternal age increases in our hospital (29), which is also a risk factor for cesarean sections (28).

There were no complications of general anesthesia. Our trainees state that they do less than one cesarean section under general anesthesia each year, finding difficulties in increasing their experience (30). During all inductions of general anesthesia, a senior anesthetist was present, which could explain that there were no complications. Incidence of anesthesia-related complications during cesarean section is 2.1-3.2 times higher than during vaginal delivery (13).

Team management and good communication between obstetricians, midwives and anesthetists is essential for avoiding general anesthesia for cesarean sections (18, 31). Women who are at high risk of general anesthesia, should be seen in the preoperative anesthesia consultation as early as possible during the pregnancy (27, 32). The patients with coagulopathies, back problems and refusal of anesthesia were all seen at the preoperative consultation, eventually followed by a multidisciplinary communication. Only in the 4 patients with twin delivery, the communication failed and the anesthesiologists were alerted too late.

If we compare our results with other literature, we can see that we have the same rate of conversion from regional to general anesthesia (0.3%) for emergency cesarean sections as other hospitals. In the Kingston Hospital in London,

0.1 to 1.4% of emergency cesarean sections under regional anesthesia needed to be converted to a general anesthesia between 1998 to 2011 (33). In 1997, 129 maternity wards in the United Kingdom participated to a survey: 78% of the cesarean sections were performed under regional anesthesia. There was a wide range of conversion of regional anesthesia to general anesthesia, varying from 0% to 88% (16). In 2001, the National Sentinel Cesarean Section Audit analyzed data from 99% of total births in England and Wales. A total of 32222 out of 150139 births were cesarean sections (21%) (27). The Royal College of Anesthetists audit book suggests that less than 15% of emergency and fewer than 1% of elective cesarean sections should be performed under general anesthesia (18). A study in 2004 reported rates of 9-23% (34), or 41% of the cesarean sections with immediate threat to the life for the mother or the fetus performed under general anesthesia (18). When general anesthesia was used, the most common indications were urgency in 35%, refusal of regional anesthesia (20%), failed regional anesthesia (22%), coagulation or spinal problems (6%) (35).

Our study has a role in reducing the number of cesarean sections under general anesthesia in Belgium and other countries, by identifying the risk factors and highlighting the lacunas for further research. A national database which mentions the number of cesarean sections per year is available in Belgium (29), but does not focus on the difference between regional and general anesthesia and anesthesia-related complications. Our study demonstrates the need for a national database concerning obstetric anesthesia, to reduce maternal morbidity and mortality by identifying the avoidable causes that can improve care.

CONCLUSION

Maternal or fetal distress is the most important cause of general anesthesia, followed by coagulation disorders, failed regional anesthesia, back problems and refusal of the patient. No major complications occurred. The conversion rate from regional to general anesthesia for emergency cesarean sections was low. In patients with back or coagulation problems, the cases were discussed before with a multidisciplinary team.

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