Clinical Reports

Foetal monitoring in parturients undergoing surgery unrelated to pregnancy

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Foetal heart rate and tocodynamic monitoring of the uterus was performed in five pregnant patients undergoing urgent or emergency surgery unrelated to their pregnancy. All received general anaesthesia with halothane or enflurane and nitrous oxide. The loss of beat-to-beat variation of the foetal heart rate was observed in all patients under general anaesthesia, and is probably normal for the anaesthetized foetus. Since continuous intraoperative monitoring of foetal heart rate in pregnant patients is technically feasible during peripheral surgery and during many intra-abdominal procedures, attempts should be made to monitor foetal heart rate in all anaesthetized parturients to assure that the anaesthetic is not causing foetal insult. Postoperative monitoring of uterine tone is useful in the diagnosis and treatment of postoperative premature labor.

It has been estimated that more than 50,000 pregnant women undergo anaesthesia and surgery in the United States annually.^{1,2} Although it has been recommended that foetal heart rate (FHR) should be monitored in all pregnant patients during surgery, if the transducer does not encroach on the surgical field,² there are only nine publications which mention FHR monitoring during non-obstetrical surgical procedures. Three of these articles concern pregnant patients undergoing general surgery,³⁻⁵ and six involve patients having open heart surgery.⁶⁻¹¹ None of these reports describe in detail the anaesthetic management of the patient or the effects of anaesthesia and surgery on the perioperative changes in FHR and uterine tone. We report our experience in monitoring FHR and tocodynamic changes in the uterus in five parturients receiving volatile anaesthetics for emergency and urgent general surgical procedures.

Case reports

FHR was monitored in five pregnant patients undergoing surgical procedures unrelated to their pregnancies. All were healthy prior to the onset of their surgical illness and all required emergent or urgent surgery. Table I lists each patient's age, previous obstetrical history, week of pregnancy, operation, and duration of operation. Prior to the induction of anaesthesia in each patient, the uterus was displaced to the left and sensors from a Hewlett Packard Cardiotocograph Model 8030A were positioned. Both FHR and uterine contractions were monitored in Patient 1 during anaesthesia and surgery. In the other four patients, uterine contrac-

Key words

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TABLE I Age, obstetrical history, duration of pregnancy, surgical procedure, and duration of operation

Patient	Age (years)	Gravidity	Parity	Week of pregnancy	Surgical procedure	Duration of surgery (hours)
1	37	4	3	35	Left modified radical mastectomy	3.5
2	25	3	1	30	Exploratory laparotomy, lysis of adhesions	1
3	15	1	0	28	Appendectomy	1
4	31	3	2	34	Debridement and skin grafting	3.5
5	33	5	2	32	Appendectomy	1.33

tions were not monitored intraoperatively because there was room on the abdomen for only the foetal heart rate sensor. FHR and uterine contractions were monitored in all five patients in the recovery room.

The anaesthetic management of each patient was left to the discretion of the anaesthetist. Cricoid pressure (Sellick's manoeuvre) was used during the induction of anaesthesia of all patients and the trachea was intubated rapidly.¹² Halothane or enflurane with nitrous oxide were the primary drugs used to maintain anaesthesia. Drugs administered in the perianaesthetic period are listed on Table II.

Case 1

A healthy 37-year-old 62 kg gravida 4, para 3, parturient in her 35th week of pregnancy was scheduled for a left modified radical mastectomy after a biopsy under local anaesthesia revealed that she had a carcinoma. Her only medication was prenatal vitamins. Two previous anaesthetics and surgical procedures (tonsillectomy and haemorrhoidectomy) performed when she was not pregnant were uncomplicated.

The patient was premedicated with intramuscular pentobarbitone (100 mg), meperidine (50 mg), and atropine (0.4 mg) one hour prior to surgery. Anaesthesia was induced with thiopentone, d-tubocurarine and succinylcholine and maintained with halothane in an equal mixture of nitrous oxide and oxygen. Arterial blood gases measured shortly after the start of surgery were: PO₂ 241 torr, PCO₂ 33 torr, pH

7.41. The patient's blood pressure and heart rate remained stable throughout the 3.5 hours of surgery, and her anaesthetic course was uneventful.

Segments of the FHR and measurements of uterine tension of patient 1 are shown in the Figures. Preoperatively, while the mother was still conscious (Figure 1), FHR values fluctuated between 140 and 155 beats per minute. This tracing demonstrates normal beat-to-beat FHR variation. The uterus was relaxed at this time. Within one minute after the induction of anaesthesia, there was a diminution of beat-to-beat variation of FHR (Figure 1). Intraoperatively, FHR beat-to-beat variation was absent (Figure 2). No uterine contractions were recorded. Beat-to-beat FHR variation increased during the immediate postoperative period, and the uterus began to contract (Figure 3). The contractions were suppressed with subcutaneous terbutaline (0.25 mg). FHR and beat-to-beat variability did not return to preanaesthetic values until 95 minutes after arrival in the recovery room (Figure 4).

Four and one half weeks after surgery and after five hours and 14 minutes of labor, the patient spontaneously delivered a healthy full-term female infant that had Apgar scores of eight and nine at one and five minutes.

Case 2

A healthy 25-year-old 67 kg gravida 3, para 1 female who was at 30 weeks gestation was admitted to the labour unit because of abdominal pain. Three days later she developed signs and symptoms of

TABLE II Drugs administered during the perioperative period

Patient	Premedication	Induction drugs (IV)	Maintenance drugs	Muscle relaxant (IV)	Reversal drugs (IV)	Drugs administered in recovery room
1	Pentobarbitone 100 mg IM	Thiopentone 350 mg	0.3–0.8% Halothane 50% N ₂ O 50% O ₂			Morphine
	Meperidine 50 mg IM Atropine 0.4 mg IM	d-tubocurarine 3 mg Succinylcholine 100 mg				Terbutaline
2	Meperidine 25 mg IM	Fentanyl 150 µg Thiopentone 300 mg Succinylcholine 100 mg	0.5–0.6% Halothane 70% N ₂ O 30% O ₂	Metocurine 12 mg	Glycopyrrolate 0.6 mg Neostigmine 3 mg	Terbutaline
3	Morphine 10 mg IV	Thiopentone 300 mg d-tubocurarine 3 mg Succinylcholine 100 mg	1.0% Enflurane 66% N ₂ O 33% O ₂ Morphine 5 mg IV × 2	Pancuronium 3.5 mg	Atropine 0.8 mg Neostigmine 3 mg	Terbutaline Morphine
4	Morphine 10 mg IM Phenergan 50 mg IM	Thiopentone 350 mg Metocurine 15 mg Pancuronium 5 mg	0.7% Enflurane 50% N ₂ O 50% O ₂ Morphine 8 mg IV		Atropine 0.8 + 0.6 mg Edrophonium 100 mg Neostigmine 2 mg	
5	Bictra® 30 cc P.O. Fentanyl 50 µg IV	Thiopentone 300 mg Succinylcholine 100 mg	0.6%–0.8% Halothane 50% N ₂ O 50% O ₂	d-tubocurarine 33 mg	Atropine 0.8 mg Neostigmine 2.5 mg	Morphine

small bowel obstruction. Her past medical history included a kidney stone, a spinal fusion, an appendectomy, and surgery for an ectopic pregnancy. Forty-five minutes prior to arrival in the operating suite, the patient was premedicated with intramuscular meperidine (25 mg). Intravenous fentanyl (150 µg) was administered shortly after she arrived in the operating room, because she appeared apprehensive. Anaesthesia was induced with thiopentone and succinylcholine and maintained with halothane and nitrous oxide (70 per cent) in oxygen. Muscle relaxation was augmented with metocurine and reversed with glycopyrrolate and neostigmine at the end of the one-hour surgical procedure for lysis of adhesions. The patient's intraoperative course was uneventful.

Preoperatively, FHR was between 140 and 150

beats per minute and the beat-to-beat FHR variation was normal. Immediately after anaesthesia was induced, FHR was 150 and beat-to-beat variation decreased. By the end of the procedure, FHR decreased to 130 beats per minute and there was loss of beat-to-beat variation. At the end of the first hour in the recovery room, FHR returned to between 140 and 150 beats per minute and normal beat-to-beat variation had returned.

Five days postoperatively, the patient dehiscd her abdominal incision. The wound was closed after a 55-minute surgical procedure. FHR was not monitored. The anaesthetic drugs for this procedure included nitrous oxide and oxygen, thiopentone, succinylcholine, morphine, and metocurine. Twelve days later she was discharged from the hospital and nine weeks later she spontaneously delivered a 3300

FIGURE 1 Perioperative foetal heart rate and uterine tocodynamic recording. Normal beat-to-beat FHR variation (left upper tracing) diminished within one minute after induction of anaesthesia.

FIGURE 2 FHR beat-to-beat variation was absent intraoperatively and when halothane was discontinued (upper tracing).

FIGURE 3 Beat-to-beat FHR variation increased during the immediate postoperative period (upper tracing) and the uterus began to contract frequently (lower tracing).

FIGURE 4 At 95 minutes after arrival in the recovery room beat-to-beat FHR variability returns to pre-anaesthetic patterns (upper tracing) and uterine contractions have been suppressed by subcutaneous terbutaline (0.25 mg).

gram female who had Apgar scores of seven and nine.

Case 3

Patient 3 was a 15-year-old primigravida in her 28th week of pregnancy. She arrived in the emergency room with a nine-hour history of abdominal pain, anorexia, nausea, and vomiting. She was started on terbutaline prophylactically and received intravenous morphine (10 mg) approximately 40 minutes prior to the induction of anaesthesia. In the operating room, she received d-tubocurarine followed by thiopentone and succinylcholine. Anaesthesia was maintained with enflurane and nitrous oxide (66 per cent) in oxygen. This was supplemented with intravenous morphine (5 mg) administered at 20-minute intervals during the one-hour surgical procedure. She also received pancuronium which was reversed with atropine and neostigmine. The patient's intraoperative course was uneventful. Terbutaline therapy was continued postoperatively.

Prior to the induction of anaesthesia FHR was between 150 and 160 beats per minute and the beat-to-beat FHR variation was normal. Beat-to-beat FHR variation was lost immediately after the parturient was anaesthetized. Intraoperatively, FHR remained stable between 155 and 160 beats per minute without beat-to-beat variation. Postoperatively the loss of beat-to-beat variability persisted through the first hour in the recovery-room. The patient was lost to follow up.

Case 4

Patient 4 was a 31-year-old parturient in the 24th week of her third pregnancy when she sustained a 32 per cent body surface area burn which mainly involved her lower extremities. She was transferred to Boston from St. Croix, Virgin Islands where the accident occurred. Apart from a lumbar sympathectomy performed for peripheral vascular disease that was attributed to birth control pills and smoking, her past medical history was unremarkable. She was premedicated with intramuscular morphine (10 mg) and phenergan (50 mg) and was transferred from burn intensive care unit to the operating room for debridement and skin grafting. Anaesthesia was induced with thiopentone, metocurine, and pancuronium. The primary anaesthetic was enflurane in nitrous oxide (50 per cent) and oxygen. One hour and twenty minutes after anaesthesia was induced,

the patient received a single dose of intravenous morphine (8 mg). At the conclusion of the 3.5-hour procedure, the effect of the muscle relaxant was reversed with atropine, edrophonium, and neostigmine.

FHR prior to the induction of anaesthesia was 140 and there was no beat-to-beat variation. The absence of beat-to-beat variation persisted intraoperatively. Normal beat-to-beat variation resumed shortly after the inhalation anaesthetics were discontinued and before the patient left the operating room for the recovery room.

Two days after the surgical procedure, and following a non-reactive foetal stress test, positive oxytocin challenge test and maturity index determination, an urgent C-section was performed. The patient received thiopentone, halothane, nitrous oxide, oxygen, metocurine and pancuronium for anaesthesia. A healthy 2.1 kg male with Apgar scores of seven and eight was delivered.

Case 5

Patient 5 was a 33-year-old, gravida 5, para 2, parturient in her 32nd week of pregnancy who was transferred from a community hospital after two days of abdominal pain and occasional uterine contractions. She was observed for two additional days in the labour unit where her pain waxed and waned. She was started on ampicillin and terbutaline therapy. On the day of surgery, a tender cul-de-sac mass was noted on pelvic examination and she was scheduled for an exploratory laparotomy. The patient was given an oral antacid upon arriving in the operating room. Shortly prior to the induction of anaesthesia she received intravenous fentanyl (50 µg). Anaesthesia was induced with thiopentone and succinylcholine and maintained with halothane in nitrous oxide (50 per cent) and oxygen. The patient received d-tubocurarine for muscle relaxation. Atropine and neostigmine were given to reverse the effect of the muscle relaxant. A ruptured appendix and intraperitoneal pus was found at surgery. After extending the initial midline lower abdominal surgical incision above the umbilicus, the appendix was removed.

FHR was between 150 and 160 beats per minute and beat-to-beat variation was normal when the patient arrived in the operating room. One minute after receiving the intravenous fentanyl (50 µg) beat-to-beat FHR variation decreased. This change

persisted after the patient was anaesthetized and FHR slowed while the patient was being examined under anaesthesia. During surgery FHR was monitored only intermittently because of mechanical interference by the surgeons with the sensing device. At the conclusion of the operation, the monitor was repositioned and FHR was 142 beats per minute. There was no beat-to-beat variation. The patient entered the recovery room awake and complained of pain. She was medicated intermittently with intravenous morphine (4 mg). FHR was 140–142 beats per minute with very little beat-to-beat FHR variation. FHR variability remained diminished during her three-hour recovery room stay. Uterine contractions were not recorded in the recovery room.

Ten weeks later, the patient spontaneously delivered a healthy 4.1 kg male with Apgar scores of 8 and 10.

Discussion

FHR normally varies with each heart beat. In all five cases described in this report, FHR variability was lost during anaesthesia, despite maternal haemodynamic stability. The loss of FHR variability during the perioperative period appears to be a drug-induced effect. Many intravenously administered drugs, including narcotics, barbiturates and tranquilizers will abolish FHR variability for a short period of time.^{13–15} Timor-Tritsch *et al.*¹⁶ and Taylor¹⁷ observed loss of beat-to-beat variability after thiopentone induction of general anaesthesia in patients undergoing Caesarian section. This loss of beat-to-beat variability of FHR persisted through delivery. In mothers receiving regional anaesthesia FHR beat-to-beat variability, however, was not changed.^{17,18}

The prolonged absence of FHR variability into the postoperative period points to the inhalation anaesthetics as the cause of the changes in foetal heart rate. Although it is difficult to distinguish the effects of nitrous oxide from the more potent inhalation anaesthetics, the prolonged effect on heart rate is probably due to the potent inhalation drugs since maternal and consequently foetal elimination of these drugs takes longer than nitrous oxide.¹⁹ Presumably this prolonged recovery of FHR variability reflects the rate of foetal excretion of inhalation agents across the placenta. Although the mother is conscious, the foetus may still be

subjected to the effects of the anaesthetic agent. Interestingly, the only patients that experienced a decline in FHR intraoperatively were those anaesthetized with halothane. This may be related to the greater effect of halothane on intracardiac conduction than enflurane.²⁰

The gradual decline in FHR in three of our cases should clearly be distinguished from acute bradycardia such as that reported by Douglas.⁶ Interpretation of the intraoperative FHR should be made with consideration of the antecedent FHR and changing circumstances in the course of anaesthesia and surgery – in particular, drugs administered and situations that may affect placental perfusion, such as maternal cardiovascular status and body position.

Our experience indicates that intraoperative FHR monitoring is possible during surgery in most cases. In the patient undergoing the mastectomy, excellent FHR and tocodynamometric tracings were recorded throughout the procedure. High quality FHR tracings were also obtained during the skin grafting of the burned patient. Technical problems, however, do occasionally occur. Although good recordings were obtained during the three intra-abdominal cases, there were occasional periods when FHR could not be monitored because of manipulation of the transducer by the surgeons. Despite potential technical problems, we recommend that an attempt should be made to continuously monitor FHR in all pregnant patients undergoing anaesthesia and surgery.

Residual anaesthetic drugs can potentially blunt the pain of uterine contraction during the immediate postoperative period. Therefore, postoperative tocodynamic monitoring of the uterus is essential in order to detect the onset of premature labour. This is especially important in patients who undergo intra-abdominal or pelvic surgery, because these patients are at high risk for the development of postoperative premature labour.²¹ If premature labour should develop, as in cases 1 and 2, tocolytic therapy can then be initiated.

In summary, continuous intraoperative monitoring of FHR is technically feasible in the majority of pregnant patients undergoing surgery. The administration of general anaesthesia to pregnant patients is associated with a loss of beat-to-beat FHR variability which can persist well into the postoperative period. This loss of FHR variability in association with general anaesthesia is probably normal for the

anaesthetized foetus and may not necessarily be a sign of foetal distress.

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Résumé

La surveillance des contractions utérines par tocodynamomètre ainsi que la surveillance du cœur fœtal ont été étudiées chez cinq patientes enceintes subissant une chirurgie urgente ou semi-urgente non reliée à leur état gravide. Toutes les patientes ont reçu de l'anesthésie générale avec l'halothane ou l'enflurane avec du protoxyde d'azote. La perte du "beat-to-beat variation" du cœur fœtal a été observée chez toutes les patientes subissant l'anesthésie générale, ce qui serait normal pour le fœtus anesthésié. Etant donné que la surveillance intraopératoire du cœur fœtal chez les femmes enceintes est techniquement possible lors d'une chirurgie périphérique et plusieurs procédures intraabdominales, des tentatives doivent être accomplies afin de surveiller le cœur fœtal chez toutes les patientes pour être sûr que la technique anesthésique ne provoque aucune insulte fœtale. La surveillance du tonus utérin en période postopératoire est utile dans le diagnostic et le traitement d'un travail prématuré postopératoire.