Reports of Investigation

Arrhythmias during spinal anesthesia for Cesarean section

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Purpose: Spinal block has long been considered a safe anesthesia technique for surgery. However, severe bradycardia, cardiac arrest, and other arrhythmias during spinal anesthesia have been reported and the incidence of intraoperative arrhythmias is not well established. In this study the incidence of arrhythmias during spinal anesthesia was determined.

Methods: We studied 254 healthy women undergoing Cesarean section under spinal anesthesia prospectively. Spinal anesthesia with 10 mg bupivacaine mixed with 0.2 mg morphine was performed at the L_{3-4} interspace. Intraoperative arrhythmias were recorded and verified later by a cardiologist.

Results: First degree atrioventricular block developed in nine patients (3.5%), second degree atrioventricular block in nine (3.5%), severe bradycardia (heart rate < 50 beats·min^{-1}) in seventeen (6.7%), multiple VPC in three (1.2%). The height and weight of patients with severe bradycardia, multiple VPCs, or atrioventricular block were not different from those of the other patients. However, the age of patients in the potentially dangerous arrhythmias group was greater than that in the other group ($P = 0.006$).

Conclusion: The incidence of arrhythmias as well as hypotension during spinal anesthesia for Cesarean section was higher than expected. Although most of these arrhythmias were transient and recovered spontaneously, they might unexpectedly occur and sometimes need immediate and prompt treatment. It is necessary to remain vigilant during spinal anesthesia for Cesarean section and careful monitoring of these patients is warranted, especially in older parturients.

Objectif : On a longtemps considéré la rachianesthésie comme une technique sécuritaire pour la chirurgie. Cependant, des cas de bradycardie sévère, d'arrêt cardiaque et d'autres arythmies ont été signalés pendant la rachianesthésie et l'incidence d'arythmie peropératoire n'est pas bien définie. Dans la présente étude, on a déterminé l'incidence d'arythmie pendant la rachianesthésie.

Méthode : Nous avons fait l'étude prospective de 254 femmes en santé qui ont subi une césarienne sous rachianesthésie. L'injection de 10 mg de bupivacaïne avec 0,2 mg de morphine a été réalisée dans l'espace L_{3-4}. L'arythmie peropératoire a été notée et vérifiée ensuite par un cardiologue.

Résultats : Un bloc auriculoventriculaire de premier degré s'est développé chez neuf patientes (3,5 %), un bloc de second degré chez neuf patientes également (3,5 %), une bradycardie sévère (fréquence cardiaque < 50 battements·min^{-1}) chez dix-sept (6,7 %), de multiples ESV chez trois (1,2 %). La grandeur et le poids des patientes qui ont présenté une bradycardie sévère, de multiples ESV ou un bloc auriculoventriculaire ne différaient pas de ceux des autres patientes. Toutefois, les patientes du groupe présentant des arythmies potentiellement dangereuses étaient plus âgées que les autres ($P = 0{,}006$).

Conclusion : L'incidence d'arythmie autant que d'hypotension pendant la rachianesthésie pour une césarienne a été plus élevée que prévu. Même si la plupart de ces arythmies ont été transitoires et sont disparues spontanément, elles peuvent survenir inopinément et exiger parfois un traitement rapide et immédiat. Cette situation appelle à la vigilance et au monitorage suivi de ces patientes, justifié surtout chez les parturientes plus âgées.

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SUBARACHNOID block has long been considered a safe anesthetic technique for surgery. In addition, small doses of intrathecal morphine produce effective intraoperative and postoperative analgesia.[1,2] Therefore, combined intrathecal administration of morphine and bupivacaine for Cesarean section has been widely used during the current decade. However, severe bradycardia, cardiac arrest, and other arrhythmias during spinal anesthesia have been reported.[3–6] The incidence of these arrhythmias is not well established.[7] Therefore, we prospectively studied 254 healthy women undergoing Cesarean section under spinal anesthesia to determine the incidence of intraoperative arrhythmias.

Methods

After ethics committee approval, informed consent was obtained from all patients. From December 1, 1998 until May 31, 1999, we prospectively collected 254 cases, including twin pregnancy in five parturients, who had consented to spinal anesthesia for Cesarean delivery at our hospital. Parturients who had arrhythmias including multiple VPCs or atrioventricular (AV) block, who had systemic disease including hypertension, valvular heart disease, or thyroid gland dysfunction, who were taking any medication other than vitamins, those who had received epidural labour analgesia before Cesarean section, and those who needed other anesthesia or analgesia for inadequate spinal block were excluded.

No premedication was given. In the operating room, automatic noninvasive blood pressure at two minute intervals, and pulse oximeter were applied. The ECG, lead II, was continuously monitored (Hewlett Packard, CMS 24 OmniCare). Patients received nasal oxygen supplementation at 2 $L \cdot min^{-1}$ and a rapid infusion of 20 $mL \cdot kg^{-1}$ lactated Ringer's prior to anesthesia. Then, with the patients in the right lateral decubitus position, spinal puncture was performed at the $L_{3\text{-}4}$ interspace and 10 mg hyperbaric bupivacaine 0.5% mixed with 0.2 mg morphine were administered. The patients were immediately turned supine and the operating table was positioned in a left lateral tilt to achieve left uterine displacement. The levels of the block to pinprick were measured at five minute intervals. If systolic blood pressure was < 100 mmHg or 80% of baseline, intermittent 8 mg boluses of ephedrine *iv* were given. All parturients with severe bradycardia (heart rate < 50 min^{-1}) received 0.5 - 1 mg atropine *iv*.

The ECG was closely observed by the anesthesiologist. When arrhythmias occurred, the ECG was recorded and the unit allowed the recording to commence five seconds before the trigger (Hewlett Packard, REC M1116B). The ECG records were verified later by a cardiologist. Outpatient department follow-up and 24-hr Holter study were suggested to all parturients with second degree AV block. The condition of the neonatal was evaluated by Apgar scores at one and five minutes.

To identify the most important individual risk factors associated with potentially dangerous arrhythmias,[8] patients with severe bradycardia, multiple VPCs, or AV block were compared with the other patients.

Statistical analysis

Statistical analysis was performed using: 1) Spearman's rank correlation coefficient to correlate spread of blockade with age, body height and weight.[9,10] Dermatomal levels, age, body weight and height were changed to rank scales before statistical analysis. 2) Unpaired Student's t test to evaluate the risk factors for AV block, severe bradycardia and multiple VPC. Differences were considered to be statistically significant when $P < 0.05$ and data were presented as mean ± SD.

Results

The patient demographics, including age, body height and weight, are shown in Table I. The maximum cephalad levels of analgesia to pinprick after spinal block are shown in the Figure. There was no correlation between patient age, body height, body weight and the maxi-

TABLE I Characteristics of patients.

	Age (yr)	*Height (cm)*	*Weight (kg)*
Mean ± SD	29.3 ± 4.5	157.8 ± 5.2	68.9 ± 10.4
Range	18 ~ 43	140 ~ 173	46 ~ 110

TABLE II Case number and incidence of of arrhythmias.

Arrhythmia	*Case number*	*Incidence (%)*
Mobitz type II	3	1.2
Atypical Wenckebach periods[1 2]	4	1.6
Mobitz type I	2	0.8
First degree AV block	9	3.5
Bradycardia	17	6.7
Multiple PVCs	3	1.2
PVCs	21	8.3
APC	45	17.7
Supraventricular rhythm	21	8.3
Sinus arrhythmia	77	30.3

Incidence = Arrhythmia case number ÷ All patients number (254)
Bradycardia: heart rate < 50 min^{-1}
Multiple PVCs: > 6 $\cdot min^{-1}$

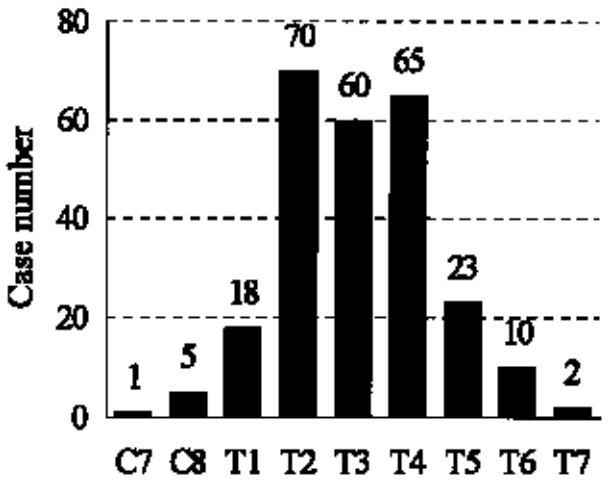

FIGURE Maximum cephalad extent of analgesia to pin prick.

mum cephalad spread of anesthesia. Hypotension occurred in 160 cases (63%), and the duration of hypotension varied from two to 16 min. Except for one premature newborn who died and in whom congenital heart disease was suspected, 258 newborns had Apgar scores ≥ 7 at one and five minutes.

The incidence of arrhythmias is shown in Table II. The ECG recordings exhibited episodes of transient second degree AV block in nine parturients. One case occurred after spinal anesthesia and during uterine repair, four after spinal anesthesia, one after skin incision, and three during delivery. The duration of each episode was < three minutes. There were two cases of Mobitz type I which had typical Wenckebach periods. Three cases presented blocked atrial depolarization with a preceding constant conduction time were Mobitz type II. The PR intervals of the other four cases increased or decreased haphazardly; they were atypical Wenckebach periods. Five parturients with second degree AV block, including all patients with Mobitz type II, agreed to 24-hr Holter study. None showed any degree of AV block. All of these nine parturients have no symptomatic arrhythmias after more than three months follow-up.

There were 17 parturients (6.7%) who manifested severe bradycardia. Most improved after administration of atropine. Without warning, one patient suddenly developed severe bradycardia (heart rate: $23 \cdot min^{-1}$) accompanied with loss of consciousness when the uterus was repaired. Surgery was stopped, 1 mg atropine *iv* was administered and the lungs were ventilated with O_2 100% via a face mask. About three minutes later, she had recovered completely and surgery was resumed. After that, the anesthetic course and hospital stay were uneventful.

The body height, and weight of parturients with severe bradycardia, multiple VPCs, or AV block were not different from those of the other parturients. However, the age of patients in the potentially dangerous arrhythmias group was greater than that in the other group (31.3 ± 4.4 *vs* 29.0 ± 4.4 yr, $P = 0.006$).

Discussion

Severe bradycardia, multiple VPCs, or AV block adversely affected circulatory function, or was likely to initiate more dangerous ventricular arrhythmias. On the contrary, APCs, VPCs, sinus arrhythmia, or supraventricular rhythm had minimal impact on cardiovascular function and usually did not require treatment.[8] Therefore, patients with severe bradycardia, multiple VPCs, or AV block were compared with the other patients to identify the most important individual risk factors of potentially dangerous arrhythmias. Our study revealed that increasing age increased the chance of developing arrhythmias and there was no correlation between arrhythmias and other factors, such as body height, or weight. These results were similar to those described by Carpenter *et al.*[7] However, they studied all patients consenting to spinal anesthesia for surgery, not only for Cesarean section. High spinal block was required for Cesarean section, the sensory levels in 242 patients (95.3% of total patients) in our study were above T_6. Sympathetic blockade might be two segments higher than the sensory block, namely, the thoracic sympathetic ganglia were almost blocked for the mojority of our patients. Therefore, the incidence of arrhythmias in our study was higher than that in Carpenter *et al.* study (2.1%).

The distinction between Mobitz type I and type II block is descriptive. Mobitz type I is diagnosed by the presence of blocked atrial depolarization preceded by prolongation of the PR interval. Mobitz type II AV block manifests with several consecutive impulses that are conducted with a constant conduction time and that are followed by a block of conduction.[11] In our study, there were four cases in whom the PR intervals increased or decreased haphazardly. It was not necessarily the longest PR interval that was followed by the blocked impulse. Denes[12] called such episodes "atypical Wenckebach periods", although some authors refer to them as Mobitz type II,[13] "Mobitz type II-like",[14,15] "pseudo mobitz type II"[16,17] or "apparent Mobitz type II".[14] However, the site of block is probably a more important determinant of prognosis and the need for pacemaker therapy than the type of block.

Usually, Mobitz type I AV block is due to excess vagotonia and the site of the block is within the AV node. The likelihood of the development of complete AV block may be very low. Usually, Mobitz type II is associated with a wide QRS complex and is due to disease of the His-Purkinje system.[18] It is more likely associated with a high mortality rate and requires a pacemaker to prevent more advanced AV block or cardiac arrest. However, electrophysiologic studies in Mobitz type II block with narrow QRS complexes (absence of bundle-branch block) sometimes localized the block at the AV node or proximal His-bundle.[13,19–21] Some studies demonstrated that vagal activity could modify AV conduction to produce first degree to complete heart block including Mobitz type II.[13,20–25] For vagally mediated AV block, the decision regarding the use of pacemakers is not based on the type of block or on QRS duration but on the underlying clinical settings and the correlation of symptoms.[26] For all our patients with second degree AV block, the prognosis was benign, because they had narrow QRS complexes and only occurred transiently during spinal anesthesia without significant ventricular pause.

There were 17 cases (6.7%) of severe bradycardia during spinal anesthesia in our patients. There are no studies of the relation between neonatal outcome and maternal bradycardia during anesthesia. However, maternal bradycardia might reduce uterine blood flow. To protect both the fetus and the parturient, all of the parturients with severe bradycardia received 0.5 - 1 mg atropine *iv*. One case suddenly developed severe bradycardia and loss of consciousness without warning Thus, we emphasize the importance of careful monitoring of patients and early management of side effects. These may be the keys in preventing more dangerous conditions, such as asystole.

There are many mechanisms to explain the high incidence of intraoperative arrhythmias. First, the cephalic spread of spinal block induced a relative increase in parasympathetic activity by blockade of cardiac sympathetic stimulation or vasovagal attack through decreased venous return.[6] The differences in latency and duration of various cardiac tissues in response to this unstable autonomic tone[22] might encourage arrhythmias. Second, nausea, vomiting and surgical manipulation during Cesarean section might also increase vagal tone. The relative increase in parasympathetic activity was not associated only with hypotension, but also with bradycardia and AV block in our study. Third, there were four cases of second degree AV block occurring immediately after intravenous ephedrine for hypotension or atropine for bradycardia. Though AV nodal conduction was enhanced and intranodal block tended to decrease after administration of atropine,[27] some studies have shown that atropine that only minimally improved conduction in the AV node, but markedly increased the sinus rate. This could increase the degree of block as a result of the increasing atrial rate.[19,20] Spear *et al.* demonstrated differences in the latency, duration and threshold of the SA node and the AV conduction in response to the sympathetic effect.[22] This mechanism was like "tachycardia-dependent conduction disturbance", AV block might occur after increased vagal tone stopped, due to the relatively prolonged AV nodal refractoriness.[26] Fourth, hemodynamic, hormonal, autonomic, and emotional changes related to pregnancy might be associated with arrhythmias.[28,29]

Body height has been considered an important determinant of the dose of spinal anesthesia although some evidence suggested no correlation between body height or weight of parturients and spread of spinal block.[30,31] In our study, all parturients were given the same dose of spinal anesthetic agent. There was no difference between age, body height, weight and spread of the blockade. Thus, it is not necessary to vary the dose of hyperbaric bupivacaine according to parturient's age, body height or weight.

In summary, our study showed that the incidence of arrhythmias as well as hypotension during spinal anesthesia for Cesarean section was higher than we expected. Although most of these arrhythmias were transient and recovered spontaneously, they might occur unexpectedly and, sometimes, require immediate treatment. It is necessary to remain vigilant and careful monitoring of patients during spinal anesthesia for Cesarean section is warranted, especially in older parturients.

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