Abstract: Background: Failed spinal anesthesia for cesarean sections may require conversion to general anesthesia. The aim of this study was to determine whether the administered spinal bupivacaine dose for performing a cesarean section under spinal anesthesia was related to the conversion rate to general anesthesia.

Methods: Retrospective analysis was performed on 1252 electronic data and file of patients who underwent a cesarean section under spinal anesthesia between 2004 and 2011.

Results: In 15 patients, spinal anesthesia was converted into general anesthesia due to block failure. Patients in whom a bupivacaine dose of 8 mg or smaller was administered had significantly higher conversion rate (3/61 (4.9%) patients and 12/1191 (1.0%) patients, respectively; \( p < 0.05 \)). The relative risk of conversion with a 8 mg dose or lower is 4.88 (95% CI 1.41 - 16.85).

Conclusion: This retrospective study shows that a low dose administration of bupivacaine 0.5% for spinal anesthesia in cesarean section patients elicits significantly more frequent conversion to general anesthesia.

Keywords: Cesarean section.

Introduction

According to international obstetric and anesthesia guidelines, neuraxial anesthesia techniques are preferred to general anesthesia for most cesarean deliveries (1). Single shot spinal anesthesia using 0.5% bupivacaine is most often used.

Maternal hypotension with its maternal and neonatal consequences is one of the main side-effects of single injection spinal anesthesia for cesarean section. As this seems to be dose-related, low-dose spinal bupivacaine has been proposed for cesarean delivery (2).

One major drawback of this approach is the possibility of an increase in spinal anesthesia failure rate, or intraoperative discomfort requiring conversion to general anesthesia. Arzola and Wieczorek performed a systematic review and meta-analysis of the efficacy of low-dose bupivacaine in spinal anesthesia for cesarean delivery (3). They included 12 studies reporting 693 participants. Conversion to general anesthesia occurred in these controlled clinical studies only in two patients of the low-dose (< 8 mg) bupivacaine group.

Historically in our center, the Radboud University Medical Centrum, no protocol or standard operating procedure existed for spinal bupivacaine dosing for cesarean delivery. The range of bupivacaine doses used by individual anesthesia staff members was large. This offered a unique opportunity to design a retrospective review audit in order to give the following question an answer: 'in a real-world scenario, is spinal bupivacaine dose for a cesarean section under spinal anesthesia related to the conversion rate to general anesthesia?'

Methods

This research was approved by the Local Research Ethics Committee (Commissie Mensgebonden Onderzoek, Radboud universitair medisch centrum, Geert Grooteplein, NL-6500 HB Nijmegen; protocol number: 2013/474; date of approval: 1.11.2013). It was retrospectively performed on electronic records and files of patients having undergone cesarean section between 2004 and 2011.

In our Institution, the Radboud Universitair Medisch Centrum, intraoperative data related to cesarean sections are compiled into a digital recording...
system, Compurecord (Philips, Eindhoven, Netherlands) since 2004. The generated database contains demographic data and clinical information, including anesthetic technique, administered medications, and vital signs. In this study, relevant data were extracted from the Compurecord database and edited in a spreadsheet.

Compiled data included elective versus emergency cesarean section, anesthesia technique, demographic data, administered bupivacaine dose and baricity, and addition of intrathecal sufentanil. In addition, the administration of suxamethonium, rocuronium, isoflurane, and sevoflurane, the most commonly used muscle relaxant and vaporized anesthetic drugs during general anesthesia for cesarean section in our Institution was reviewed.

Doses of intrathecal 0.5% bupivacaine and opiates were analyzed. Only bupivacaine doses between 5 and 15 mg were considered, insofar as doses out of this range for a single-shot spinal anesthesia for cesarean section are very unlikely. Should such a dose being recorded, a registration error was strongly suspected. Similarly, only spinal sufentanil doses between 1 and 5 microgram were considered.

We sought at a relationship between the administered intrathecal dose of bupivacaine and conversion rate to general anesthesia, taking account of patient height and weight. No distinction was made between hyperbaric (with glucose) and isobaric (without glucose) bupivacaine, for the reason that we were focusing on bupivacaine dose only. All files of patients who underwent a cesarean section with concomitant documented spinal and general anesthesia were reviewed, as well as those in which conversion was documented as a complication of anesthesia. Detection of those files within the database was made using key events, including the intrathecal administration of bupivacaine (spinal anesthesia), and the administration of suxamethonium, rocuronium, isoflurane or sevoflurane (general anesthesia).

As the anesthesia records were reviewed for the reason of conversion and for the relationship between dosage of bupivacaine and conversion, it was relevant to only include conversions due to block failure. Block failure was defined as inadequate sensory block or insufficient anesthesia during the procedure.

To analyze the relationship between the dose of bupivacaine and the number of conversions, IBM SPSS Statistics 20 (IBM, Armonk, New York, USA) was used to calculate Fisher’s exact test. According to ARZOLA and WIECZOREK (3), a bupivacaine dose ≤ 8 mg was considered as low dose.

RESULTS

From 2004 to 2011, a total of 2329 cesarean sections were performed in our Institution. Four cases were excluded from further analysis due to lack of information about anesthesia technique and administered medication. Of the remaining 2325, 851 (36.6%) had an elective, and 1415 (60.9%) an emergency procedure. The remaining 59 were (2.5%) of an unknown character. This total includes patients having received epidural anesthesia and spinal anesthesia through a spinal catheter.

Single bolus spinal anesthesia was used in 1573 out of 2325 patients (67.6%), including conversions, and 376 (16.2%) cases were managed using general anesthesia as the primary technique. Epidural anesthesia concerned 371 patients (16.0%), and spinal anesthesia through a spinal catheter 5 cases (0.2%). The three latter categories were excluded from further analysis to conform to the study question involving single bolus spinal anesthesia only. Flow chart of patient repartition is shown in Figure 1, and Table 1 provides descriptive statistics about anesthesia technique repartition and emergency type. The number of cases labeled as ‘general anesthesia’ includes all cesarean sections that were performed using general anesthesia as the primary technique. The spinal bolus cases include spinal anesthesia and spinal anesthesia converted to general anesthesia.

In 1252 out of 1573 single bolus spinal anesthesia cases (79.6%), bupivacaine 0.5% dose ranged between 5 and 15 mg, including patients with failed spinal anesthesia. In the remaining 321 (20.4%) cases, the local anesthetic agent dose was not known, or bupivacaine dose was out of the 5 to 15 mg range. These patients were excluded from further analysis. The mean administered dose of bupivacaine was 11.1 mg (SD 1.6, median 11.0 mg).

Figure 2 shows the distribution of the bupivacaine dose for elective, emergency cesarean sections and cases where emergency grade is unknown. Doses of 10.0 and 12.5 mg are most often administered. A dose of 10.0 mg was administered in 389 (31.1%) patients, and a dose of 12.5 mg in 450 (35.9%) patients. In 61 patients, a dose of 8 mg or smaller was administered, and, in 1191 patients, the bupivacaine dose was higher than 8 mg.

Figure 3a shows the relationship between bupivacaine dose and patient weights (kg). Weight was recorded in 1159 cesarean section patients (92.6%) having received bupivacaine spinal anesthesia [mean = 82 kg (SD 17); minimum = 43 kg; maximum = 163 kg]. The Pearson’s correlation co-
d. seljogI et al. opioid intrathecally. The addition of an opioid was more frequent in patients who received a low dose of bupivacaine (≤ 8 mg) (40 of 61 patients; 65.6%) than in patients with a bupivacaine dose higher than 8 mg (39 of 1191 patients; 33.1%). Sufentanil was the most commonly administered opioid, and was administered in 391 cases (31.2%). Thirty-three patients (2.6%) received intrathecal fentanyl and 10 of them (0.8%) received intrathecal morphine.

Conversion from spinal anesthesia to general anesthesia occurred in 23 patients. In 2 patients, the decision to convert was made before the beginning of surgery. In those patients, a Wertheim-Meigs surgical procedure was performed, due to cervix carcinoma that was diagnosed during pregnancy.

Figure 3b shows the bupivacaine doses plotted against the patients’ height (cm). Height was recorded in 1060 (initially) spinal anesthesia patients (84.7%) patients. [mean = 168 cm (SD 7.1); minimum = 134 cm; maximum = 193 cm]. The corresponding Pearson’s correlation coefficient was 0.101 (p < 0.001), indicating that the taller the patient, the higher the bupivacaine dose the patient tends to receive.

According to our data extracted from Compu-record, 434 spinal anesthesia patients (34.7%) who received 0.5% bupivacaine additionally received an opioid intrathecally. The addition of an opioid was more frequent in patients who received a low dose of bupivacaine (≤ 8 mg) (40 of 61 patients; 65.6%) than in patients with a bupivacaine dose higher than 8 mg (39 of 1191 patients; 33.1%). Sufentanil was the most commonly administered opioid, and was administered in 391 cases (31.2%). Thirty-three patients (2.6%) received intrathecal fentanyl and 10 of them (0.8%) received intrathecal morphine.

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Table 1

<table>
<thead>
<tr>
<th>Indication</th>
<th>Spinal bolus</th>
<th>Spinal catheter</th>
<th>Epidural</th>
<th>General</th>
<th>Unknown</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elective</td>
<td>718 (45.6%)</td>
<td>2 (40.0%)</td>
<td>36 (9.7%)</td>
<td>95 (25.3%)</td>
<td>1 (25.0%)</td>
<td>853</td>
</tr>
<tr>
<td>Emergency</td>
<td>824 (52.4%)</td>
<td>3 (60.0%)</td>
<td>317 (85.4%)</td>
<td>271 (72.1%)</td>
<td>3 (75.0%)</td>
<td>1418</td>
</tr>
<tr>
<td>Unknown</td>
<td>31 (2.0%)</td>
<td>0 (0%)</td>
<td>18 (4.9%)</td>
<td>10 (2.6%)</td>
<td>0 (0%)</td>
<td>59</td>
</tr>
<tr>
<td>Total</td>
<td>1573</td>
<td>5</td>
<td>371</td>
<td>376</td>
<td>4</td>
<td>2329</td>
</tr>
</tbody>
</table>
The documented reasons for conversion were block failure in 15 patients. In these 15 patients, the mean dose of bupivacaine was 10.7 mg (SD 1.8), with a minimum of 7.5 mg and a maximum of 12.5 mg. These included 5 elective procedures (0.7% of the 718 elective surgeries performed using a first-line single-shot spinal anesthesia) and 10 emergency procedures (1.2% of the 824 emergency surgeries performed using a first-line single-shot spinal anesthesia).

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When bupivacaine dose was equal to or smaller than 8 mg, the conversion rate for block failure was significantly higher (4.9% and 1.0%, respectively; Fisher’s exact test: \( p < 0.05 \)). These conversions included 3/61 patients who received a bupivacaine dose of 8 mg or lower, and 12/1191 patients who received a dose higher than 8 mg. The relative risk of conversion with this lower dose is 4.88 (95% CI 1.41-16.85). The distribution of these dosages is shown in Table 2. Organizing the dosages in three groups (7.5 to 9 mg, 10 to 11 mg, and 12 mg or above) yielded the following results: 4/122 conversions (3.3%) in the 7.5 to 9 mg group, 4/514 conversions (0.8%) in the 10 to 11 mg group, and 7 conversions (1.2%) in the 12 mg or above group.

Vaspressors or atropine were administered in 894/1252 (71.4%) of patients having received spinal anesthesia. Ephedrine was given in 647 (51.7%) and phenylephrine in 185 (14.8%). Atropine was administered in 62 patients (5.0%). Out of all patients having received less than 8 mg bupivacaine, 25 (41.1%) received vasoressors and/or atropine, while this number was 869 (73.0%) in patients having received 8 mg or more. Ephedrine or phenylephrine was administered in 24 patients (39.3%) in the low dose group, and in 808 patients (67.8%) in the high dose group.

**DISCUSSION**

This retrospective study shows that a low dose administration of bupivacaine 0.5% for spinal anesthesia in cesarean section patients elicits significantly more frequent conversion to general anesthesia than higher dose bupivacaine spinal anesthesia. The conversion rate from spinal anesthesia to general anesthesia during cesarean section in our study is in accordance with the proposed standards of best practice by the Royal College of Anaesthetists, which poses that this conversion rate should be less than 1% for elective cesarean sections, and less than 5% for emergency cesarean sections (4). Interestingly, in our retrospective study, approximately a third of all conversions to general anesthesia were not caused by block failure itself, but was motivated by surgical reasons like substantially prolonged surgery due to technical difficulties or massive intraoperative blood loss with hemodynamic consequences.

The main anesthesia-related reason for failed spinal anesthesia was inadequate block. Several reasons may be advocated, including errors in the preparation of injected solutions, inadequate spreading of drugs through the cerebral spinal fluid, and failure of drug action on the nervous system (5). The administered dose may influence intrathecal drug spreading, depending on the type of local anesthetic agent, baricity of the solution, posture of the patient immediately after injection, and anticipated duration of surgery (6).

For cesarean section, maternal hypotension should be minimized to avoid maternal and neonatal deleterious consequences. This may be obtained by injecting lower doses (7, 8). However, lower doses may lead to reduced margins for successful block. A combined spinal-epidural anesthesia (CSE) is an elegant solution, whereby a low intrathecal dose can be used with the safety of an epidural top-up option (9). Nonetheless, considering its low price, technical simplicity, and overall availability, single-shot spinal anesthesia remains the most used regional anesthesia technique for cesarean delivery.

This study suggests that administration of a low bupivacaine dose (≤8 mg) for single-shot spinal anesthesia is related to a higher conversion rate, in the range of 5% as compared to 1.0% in the high dose group. These findings are consistent with
the meta-analysis by Arzola and Wieczorek (3), enclosing a total of 12 studies and 693 patients, which observed only two conversions to general anesthesia in one study involving 21 participants in the low dose group (0.5% hyperbaric bupivacaine 6.5 mg with fentanyl 20 mg), while there were no reported conversions in the high dose group in any of the scrutinized studies.

Our study has several limitations. First, it is retrospective in nature, and data documentation did not take place under controlled conditions. This could be a reason for more recording errors and/or missing data. In 321 patients (20.4%), the administered local anesthetic dose was not documented, or the dose of bupivacaine was not between 5 and 15 mg. We are well aware that, particularly during emergency cesarean delivery, the focus is more on patient care than on data documentation. Nonetheless, this amount of missing or clinically not reasonable data seems to be quite high. This prompted us to suggest a change in our data documentation system. At the moment, the anesthesia data record file cannot be closed without a plausible bupivacaine dose being entered. If the dose is out of the 5-15 mg range, an alarm advises the practitioner. According to our database, a surprisingly low 34.7% of cesarean sections under spinal anesthesia were performed using concomitant administration of bupivacaine 0.5% and opioid intrathecally. Insofar as the addition of sufentanil provides effective and prolonged analgesia with a fast onset of sensory and motor block, and minimal side effects (2, 10), we also suggested a change in the anesthesia data documentation system. A sufentanil dose must always be entered into the system before one is able to close the file. A dose of 0 mg sufentanil must be recorded if no sufentanil has been given intrathecally. These recording flaws apply to all patients, regardless whether a low dose or a high dose of bupivacaine was administered.

Second, the choice of bupivacaine dose was not controlled. In clinical studies, patients should be randomized into a bupivacaine dose group. This was not the case in this retrospective review audit. Patients’ weight and height could have been factors which influenced the individual choice of bupivacaine dose. Our analysis showed a weak correlation, heavier patients receiving a slightly lower bupivacaine dose than the others. Hogan et al. measured, in a magnetic resonance imaging study, a smaller cerebrospinal fluid volume in relatively obese subjects than in non-obese subjects (11). In the study of Carvalho et al. (12), obese and non-obese patients undergoing cesarean delivery did not respond differently to intrathecal bupivacaine. Our analysis shows a weak correlation with height, taller patients receiving a slightly higher bupivacaine dose. Danelli et al. (13) used an adjusted bupivacaine dose to the height of the patient and achieved an effective block height in 95% of elective cesarean sections, and a conversion rate of only 1.5%. In the study of Hiranayash et al. (14), as well as in the one of Norris et al. (15), no correlation between block height and weight or between block height and body mass index, or between block height and patient height were evidenced.

To reduce the block failure-caused conversion rate to general anesthesia in our Institution, a protocol or standard operating procedure with a bupivacaine dosing guideline according to eg. the ED 95 of the studies of Ginosar et al. (16) or Carvalho et al. (17) should be considered.

In conclusion, this retrospective study shows that bupivacaine 0.5% administered for spinal anesthesia in cesarean section patients at doses of 8 mg and lower might elicit significantly more frequent conversion to general anesthesia than bupivacaine doses higher than 8 mg.

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References


