Spread of subarachnoid block, intraoperative local anaesthetic requirements and postoperative analgesic requirements in Caesarean section and total abdominal hysterectomy

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Background. Pregnancy is associated with a higher spread of subarachnoid anaesthesia and increased pain threshold. The study was designed to assess the spread of subarachnoid block and the intra- and postoperative analgesic requirements in pregnant vs non-pregnant women.

Methods. We assessed the level of subarachnoid anaesthesia after 1.8 ml of hyperbaric lidocaine 5% and the postoperative analgesic requirements in women undergoing Caesarean section and undergoing abdominal hysterectomy (30 each group). Intraoperatively epidural ropivacaine was given as required. All patients received 10 ml of ropivacaine 0.2% epidurally 2, 10, and 24 h after operation and the VAS pain score was assessed. They also had access to patient controlled analgesia i.v. morphine.

Results. Duration of surgery was 64 (13.7) vs 127 (33.8) min (P<0.0001) in the pregnant and non-pregnant groups. Ten minutes after subarachnoid injection, sensory block was higher by three dermatomes in the pregnant group (P<0.0001). Time to first ropivacaine dose was 37 (19.7) vs 19 (12.2) min (P<0.001) and the ropivacaine normalized for the duration of anaesthesia was 0.8 (0.6) vs 1.3 (0.5) mg/cm (P=0.001) in the pregnant and non-pregnant groups, respectively. The time between the first and second ropivacaine dose was similar in the two groups (P=0.070). Fewer pregnant women (81 vs 100%) required ropivacaine intraoperatively (P=0.017). The VAS scores were similar but parturients consumed more i.v. morphine (33 (14) vs 24 (12) mg, P=0.016) during the first 24 h after operation.

Conclusions. Pregnant patients exhibited a higher level of subarachnoid sensory block and required more i.v. morphine after operation.

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A smaller dose of local anaesthetic is needed to produce the same level of neuraxial block in pregnant compared with the non-pregnant patients. The evidence of lower intrathecal anaesthetic requirements in pregnancy is in fact not very well documented. Mechanical reasons such as changes in spine curvature, distension of epidural veins as a result of aorta and vena cava obstruction by the uterus, and therefore decreased spinal and epidural spaces may be involved.

Other factors related to physiological and endocrine changes during pregnancy may be important. Pregnant women exhibit increased susceptibility to local anaesthetics, when these are administered to produce peripheral nerve blocks. In pregnant rats the antinociceptive effects of epidural lidocaine is enhanced and the levels of nociceptive responses to noxious stimuli are increased. This antinociception may be mediated by the κ- and δ-opioid receptors in the spinal cord, which are activated by the increased estrogen and progesterone levels. However, the underlying mechanisms of reduced local anaesthetic requirements and increased pain threshold during pregnancy are not clear, and there is very few hard human data on the topic.

The aim of the present study was to compare in groups of pregnant and non-pregnant patients: (i) the spread of subarachnoid anaesthesia, (ii) the doses of the local anaesthetic administered epidurally until surgery was completed, and (iii) the postoperative morphine analgesic requirements during the first 24 h after operation.
Methods

After obtaining approval from the Local Ethics Committee and patients’ written informed consent, 30 pregnant women at term undergoing elective Caesarean section (pregnant group) and 30 women undergoing elective hysterectomy (non-pregnant group) were recruited for the study. Exclusion criteria for pregnant group were ASA physical status more than II, body weight exceeding the 20 kg when compared with the body weight before pregnancy, pre- or eclampsia, hypertension, diabetes, in vitro fertilization, and emergency Caesarean section. Exclusion criteria for the non-pregnant group were body weight exceeding the 20% of the ideal body weight. Refusing to receive regional anaesthesia was an absolute contraindication for both groups. Also, subjects with central or peripheral nervous system disease, chronic abdominal pain or treated with analgesics, calcium channel blockers, α₂ agonists, antiepileptics, tricyclic antidepressants, or antiarrhythmics were not included in the study.

The assessment of the level of the sensory and motor block was explained in all patients during the preoperative visit as well as the VAS score and the use of patient controlled analgesia (PCA) after operation. The directions to the patient regarding the PCA were standardized.

Anaesthetic technique

Pre-medication was omitted. In the operating room standard monitoring (ECG, SpO₂, and non-invasive arterial pressure) was used. Before regional anaesthesia, patients in each group received 500 ml of colloid (Hydroxyethyl starch 6% HAES-steril® 6%). Each patient was placed on her left side. After disinfecting the skin and infiltration with local anaesthetic (lidocaine 2%) a 16-G (8 cm long) epidural needle (Portex®) was inserted in the L2–L3 intervertebral space. When the epidural space was identified a 27-G spinal needle was inserted through the epidural needle and when cerebrospinal fluid was seen 1.8 ml of 5% hyperbaric lidocaine was injected slowly within 15 s and without barbotage. At this point 2.5 mg of ephedrine was given i.v.. Then, the spinal needle was removed, an epidural catheter threaded through the Tuohy needle, the Tuohy needle removed and the catheter fixed in place. Intraoperatively, left lateral tilt was applied to both pregnant and non-pregnant women.

Measurements

Sensory block was assessed 10 min after the subarachnoid injection. Four points lying on the posterior, middle and anterior axillary lines of the left abdominal wall and on a line 5-cm medial to the anterior axillary line were drawn as described previously. The level of sensory block was determined unilaterally (left side) by moving a pressure palpatior (Pressure feeler 650-g Dedatelec; Chemin de Muriers, Irigny, France) along each longitudinal line in a caudal to cephalad direction as described previously. The four points, each representing the level of the block, were joined by a line, which determined the dermatome at which sensory block had occurred.

Motor block was also assessed for each lower limb 10 min after subarachnoid injection, using the modified Bromage scale (patient could move nothing, 3; move the hip, 2; flex and extend the knee, 1; flex and extend the foot, 0). Sensory and motor block were also assessed at the end of surgery.

Conduct of anaesthesia

All patients received a Pfannenstiel incision. Intraoperatively 6 ml of ropivacaine 0.75% was administered epidurally each time the patient complained of ‘starting to feel something pulling’ at the level of the epigastrium. To enhance the spread of sensory block after epidural injection, 50% of nitrous oxide in oxygen was given as long as required for the patient to feel comfortable. The time to the first dose of ropivacaine, the number of ropivacaine doses required intraoperatively, the time elapsed between the first and second epidural dose of ropivacaine, and the duration of nitrous oxide administration were recorded. To compare the epidural ropivacaine requirements intraoperatively between the two groups, the ropivacaine doses given in each patient intraoperatively were recorded for the duration of anaesthesia by dividing the intraoperative doses of ropivacaine in milligrams by the duration of anaesthesia in minutes. We defined as duration of anaesthesia the time from subarachnoid injection to the end of surgery (skin closure), and duration of surgery from the skin incision to skin closure. Ephedrine administration was repeated when systolic arterial pressure was more than 20% of the baseline recorded in the operating room before any intervention. The doses of ephedrine given in each group were also recorded.

Postoperative care and analgesia

All patients received 10 ml of ropivacaine 0.2% epidurally 2, 10, and 24 h after surgery. At these time intervals pain was assessed at rest and after cough using the VAS score. Assessment was done before ropivacaine injection. Patients also had access to i.v. morphine via a PCA device (Freedom5®, VYGON, B.P. 7, 95440 Ecouen, France). This device allows delivery of 1 ml solution, containing 1 mg of morphine with lockout interval of 7 min. During the first 24 h after surgery patients did not receive other analgesics such as paracetamol or NSAIDs, except those predetermined by the study protocol, such as epidural ropivacaine and PCA i.v. morphine. Patients were examined 24 and 48 h after the operation for transient neurological symptoms defined as: back pain and/or dysesthesia radiating to the buttocks, thighs, hips, or calves and began within the first 24 h after surgery.

Statistical analysis

Initial sample size estimation (eight patients in each group) showed that approximately 30 subjects should be included in each group in order to ensure power of 0.80 for detecting a clinically meaningful difference of 25% difference in...
morphone dose (expressed in milligrams) as well as a difference of one dermatome between the two groups. Standard deviations (SD), estimated from initial pilot observations, were 11 and 1.9 for morphine dose and dermotal spread, respectively. The α error was assumed to be 0.05. Levene’s test was used to compare the equality of variances.

Patient characteristics, duration of surgery and anaesthesia, the time until the first ropivacaine dose was given, the total number of ropivacaine doses, cumulative ropivacaine doses, the dose of ephedrine required, the duration (minutes) of nitrous oxide administration, and the postoperative morphine requirements were compared between the groups using independent sample t-tests. The time interval between the first and second dose of epidural ropivacaine was compared between the groups with the Mann–Whitney test. To compare the level of sensory block between the pregnant and non-pregnant groups 10 min after subarachnoid anaesthesia and at the end of anaesthesia.

Results

In the pregnant group one woman received only epidural anaesthesia for technical reasons, one received general anaesthesia because of failure of the block, and a third woman was intubated because of a high block and difficulty in breathing. The three women were excluded from the study. In the non-pregnant group two patients who exhibited incomplete block and received general anaesthesia were also excluded from the study.

The pregnant and non-pregnant groups did not differ regarding body weight (71 (7.9) vs 66 (9.9) kg, respectively) and height (164 (0.05) vs 165 (0.05) cm, respectively). A difference was found in age between the pregnant and non-pregnant group (32 (4.52) (24–43) vs 40 (7.6) (23–50) yr, respectively, P<0.0001). Duration of surgery was shorter in the pregnant group (64 (13.7) vs 127 (33.8) min, respectively, P<0.0001) as well as duration of anaesthesia (81 (15.4) vs 146 (33.9) min, respectively, P<0.001).

Ten minutes after subarachnoid injection the two groups did not differ regarding the motor block of the right or the left leg. Sensory block assessed 10 min after the subarachnoid injection was higher in the pregnant group by three dermatomes (T5) when compared with the non-pregnant group (T8) (P<0.001). At the end of surgery the two groups did not differ in sensory or motor block (Table 1).

The time to first ropivacaine dose was longer and the number of patients who asked for ropivacaine doses, the number of ropivacaine doses, the dose of ropivacaine normalized for the duration of surgery (mg min⁻¹), and the duration of nitrous oxide administration were significantly less in the pregnant group (Table 2). The time elapsed from the first to the second ropivacaine dose did not differ between the two groups (P=0.07). The total dose of ephedrine given to the pregnant women (17.6 (13.5) mg) did not differ when compared with the total dose of ephedrine given in the non-pregnant women (12.8 (8.2) mg).

Using the Kolmogorov–Smirnov test we found that morphine followed a normal distribution in both pregnant

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Table 1 Sensory block (dermatomes, mean and range), and right and left motor block (number of patients with motor block assessed with a modified Bromage scale) in the pregnant and non-pregnant patients 10 min after the subarachnoid injection and at the end of anaesthesia. *P<0.001 vs the non-pregnant group.

<table>
<thead>
<tr>
<th>Group</th>
<th>Sensory block</th>
<th>Motor block</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10 min after subar. anaesthesia</td>
<td>End of surgery</td>
</tr>
<tr>
<td>Pregnant (n=27)</td>
<td>T5* (L1–T2)</td>
<td>T11 (L3–T5)</td>
</tr>
<tr>
<td>Non-pregnant (n=28)</td>
<td>T8 (L1–T5)</td>
<td>T12 (L5–T9)</td>
</tr>
</tbody>
</table>

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Table 2 Time to first ropivacaine dose (min), patients (%) who required doses of epidural ropivacaine, number of ropivacaine doses per patient, normalized ropivacaine doses (mg min⁻¹) for the duration of anaesthesia, and duration of nitrous oxide administration (min) in each group. *P<0.001, **P=0.017, †P<0.001, ‡P<0.001, §P<0.007 vs the non-pregnant group. Values are mean (sd).

<table>
<thead>
<tr>
<th>Group</th>
<th>Time to first ropivacaine dose</th>
<th>No. and (%) of patients who required ropivacaine</th>
<th>Ropivacaine doses/patient</th>
<th>Normalized doses of ropivacaine</th>
<th>Duration of N₂O administration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pregnant</td>
<td>37 (19.7)*</td>
<td>22** (81%)</td>
<td>1.6 (1.0)†</td>
<td>0.8 (0.6)§</td>
<td>9 (2.0)†</td>
</tr>
<tr>
<td>Non-pregnant</td>
<td>19 (12.2)</td>
<td>28 (100%)</td>
<td>4.0 (1.2)</td>
<td>1.3 (0.5)</td>
<td>20±14</td>
</tr>
</tbody>
</table>
null = 0.141) and non-pregnant (null = 0.080) women. Morphine consumption was significantly higher in the pregnant (33 (14) mg, range 2–54) than in the non-pregnant patients (24 (12) mg, range 3–50 maximum) (null = 0.016). The VAS scores at rest and after cough did not differ between the pregnant and non-pregnant patients (Figs 1 and 2, respectively). Regarding neurological symptoms after surgery, one patient in the pregnant group complained of pain in the back and buttocks and one patient in the non-pregnant group complained of burning in the heels. These symptoms regressed in the following days.

Discussion

We demonstrated in a prospective controlled manner that after subarachnoid injection of hyperbaric lidocaine, pregnancy is associated with higher levels of sensory block when compared with the levels of subarachnoid block in non-pregnant patients, undergoing abdominal hysterectomy. The evidence of lower intrathecal local anaesthetic required in pregnancy is not well documented and no prospective human studies are available. Results from animal experiments may not be applicable to humans. On the other hand, the human studies available tackle the problem from a different angle.

Changes in curvature of the spinal column in the later stages of pregnancy, such as the apex of lumbar lordosis to be caudal and thoracic kyphosis to be reduced in the supine position may enhance the cephalad spread of local anaesthetic. Another reason for the wider spread of subarachnoid local anaesthetic may be the enlargement of the epidural veins as a result of obstruction of the inferior vena cava by the gravid uterus and therefore a decrease in the volume of cerebrospinal fluid. Finally, high progesterone levels in CSF and/or blood may be the cause of the different response to subarachnoid injection of local anaesthetic during late pregnancy. However, the increased levels of progesterone during the second but not during the first trimester were associated with higher levels of sensory subarachnoid block.

Though we found a difference regarding the sensory block between the groups, the motor block did not differ between the pregnant and non-pregnant subjects. However, after hyperbaric lidocaine most of the patients had a dense motor block, which when above the level of T10 is difficult to establish clinically. Therefore, it is impossible to demonstrate a difference in motor block between the groups.

We used the lidocaine 5%, as local anaesthetic for subarachnoid injection as no other licensed local anaesthetic was available for subarachnoid anaesthesia in Greece at the time of the study. The transient neurological symptoms in the two patients occurred within 24 h and resolved without any treatment. Aouad and colleagues reported a 3% incidence of transient neurological symptoms after subarachnoid lidocaine for Caesarean section, and a height of sensory block at T4.

Measurements of sensory block were made only 10 min after subarachnoid injection, as delaying surgery was undesirable for patients, particularly if pregnant. The non-pregnant subjects consumed more epidural ropivacaine intraoperatively, the total dose of ropivacaine being normalized for the duration of anaesthesia. However, the doses of ropivacaine used are not a satisfactory guide of the epidural requirements because the duration of surgery was longer in the non-pregnant patients. To assess the height of first epidural dose was technically impossible, as we could not interfere with the sterile drapes intraoperatively. So we limited our investigation to determination of the interval elapsing between the first and second dose of epidural ropivacaine, which did not differ between the two groups.

An increased susceptibility to lidocaine neural block has been reported in pregnant rats; although spinal root axons of pregnant rats did not exhibit increased susceptibility to...
requirements in pregnant women at term vs non-pregnant women having total abdominal hysterectomy. Additional studies assessing analgesic requirements in pregnant women at term vs non-pregnant women are needed to enlighten these differences.

References

16. Diez FB, Jaffe RA. Pregnancy does not increase susceptibility to bupivacaine in spinal root axons. Anesthesiology 1997; 87: 610–6