Effects of a head elevated ramped position during elective caesarean delivery after combined spinal-epidural anaesthesia

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ABSTRACT
Background: Elevating the torso in a Head Elevated Ramped Position during caesarean delivery benefits the mother by improving comfort and ventilation while reducing reflux symptoms and providing a better airway position. We hypothesised that using an elevation pillow for an elective caesarean delivery under combined spinal-epidural anaesthesia would not significantly increase the time to achieve a T4 block.

Methods: Following ethical approval and informed consent, 60 women undergoing elective caesarean delivery under combined spinal-epidural anaesthesia were randomised to one of three groups: Control – horizontal with a small pillow under the head; Head Elevated Ramped Position – torso on an elevation pillow; and Head Elevated Ramped Position with initial position horizontal. Data collected were time to T4, block height at 30 and 120 min, adequate block at 12 min, need for epidural supplementation, maternal comfort and airway position assessment.

Results: Time to T4 among the three groups was not significantly different (P = 0.14). However, there was a significant difference in achievement of block height of T4 at 12 min and greater need for epidural supplementation in the intervention groups compared to the control group (P = 0.021). Non-inferiority analyses of time to T4 of both head elevated ramped positions were inconclusive about inferiority relative to the control. Head Elevated Ramped Position was significantly more comfortable than control (P = 0.007). Using the level of the external auditory meatus to the sternal notch as an indicator for ease of laryngoscopy, Head Elevated Ramped Position provided a significantly better position than control (P < 0.001).

Conclusion: Elevating the parturient undergoing elective caesarean delivery into the Head Elevated Ramped Position immediately or once the block had been established did not appear to significantly alter time to an adequate block height of T4; however, the need for epidural supplementation was greater in the intervention groups. Cautious use of this novel position change can provide a more comfortable experience and provide a better airway position should conversion to general anaesthesia be required.

Keywords: Head elevated ramped position; Head elevated laryngoscopy position; Block height; Combined spinal-epidural; Caesarean delivery

Introduction

The ramped position or head elevated laryngoscopy position (HELP), in which the head is visibly above the shoulders with horizontal alignment between the external auditory meatus (EAM) and sternal notch, improves the view during direct laryngoscopy compared to the sniffing position in bariatric patients. The ramped position can be achieved by inserting folded blankets under the head and shoulders, by manipulating the operating table into a back/trunk-up position or using a commercial device such as the TROOP® elevation pillow (a plastic covered foam pillow with an elevation angle of approximately 20 degrees). Other benefits of the ramped position include more efficient preoxygenation and easier bag-mask ventilation in severely obese patients.

Studies in term parturients have shown an increase in functional residual capacity and slower desaturation rates in the head-up position compared to the supine position.

Difficult or failed intubation is a known cause of maternal morbidity and mortality associated with general anaesthesia for caesarean delivery (CD). Although the majority of CDs are now performed under neuraxial anaesthesia, general anaesthesia is still required for many emergency deliveries or when complications related to neuraxial anaesthesia occur.
Ideally, all parturients having surgery would be placed in the ramped position in order to ensure the best position for intubation, if general anaesthesia were needed. However, use of the ramped position before neuraxial block is established might result in inadequate surgical anaesthesia.

The effect of the ramped position on the level of spinal anaesthesia has not been studied. We hypothesised that the position of the parturient for an elective CD in the head elevated ramped position using an elevation pillow would not significantly increase the time for a block to reach T4.

Methods

Approval was obtained from the local ethics committee (University of British Columbia, Vancouver, Canada) and the trial registered with Clinicaltrials.gov (NCT01161693). The target population was women >37 weeks of gestation undergoing elective or urgent CD under neuraxial anaesthesia, with a singleton fetus, American Society of Anesthesiologists classes 1 and 2. Exclusion criteria were general anaesthesia, women in active labour (≥3 cm dilated with regular uterine contractions), emergency CD for fetal heart rate abnormalities, maternal age <19 years, body mass index (BMI) >40 kg/m², possible uterine over-distension (e.g. polyhydramnios), estimated fetal weight >4 kg by ultrasound scan and maternal height <150 cm or >180 cm.

Following informed consent, women were randomised using a computer-generated table into one of three groups: Control (C) a standard pillow under the head (Fig. 1A); Head Elevated Ramped Position (HERP) with an elevation pillow and the operating table horizontal (Fig. 1B); and Head Elevated Ramped Position with an elevation pillow in the horizontal position (HERP-H) achieved by lowering the back of the operating table so the elevation pillow was parallel to the floor (Fig. 1C). The latter position was maintained until an adequate block had been established, after which the operating table back was levelled, making it in the same position as group HERP.

An intravenous cannula was inserted in each patient, and normal saline administered to keep the vein open. Before transfer to the operating room (OR), patients were positioned supine with a pillow under the head and a 3L inflatable wedge under the right hip to provide left uterine displacement for 3 min and then the TROOP® pillow was introduced for 3 min. Comfort was compared by responses to the question “Is elevation more comfortable than lying flat?” using a 5-point Likert scale: strongly disagree, disagree, no difference, agree, strongly agree. Whilst on the elevation pillow, the relationship of the EAM to the sternal notch was determined using a spirit level and classified as: below the level of the sternal notch (Fig. 2A) or at the level of or above the level of the sternal notch (Fig. 2B). The patient was then moved into the OR where group allocation was determined by opening an opaque envelope containing a computer-generated randomised number.

In the OR, combined spinal-epidural (CSE) anaesthesia was performed in the sitting position at or below the L3-4 interspace. The epidural space was located using loss of resistance to normal saline (amount restricted to <5 mL). Once the subarachnoid space was identified, a mixture of hyperbaric 0.75% bupivacaine 1.5 mL, fentanyl 10 μg and morphine 100 μg was administered over 15 s. The spinal needle was removed and the epidural catheter threaded 5 cm into the epidural space and secured. The patient was immediately positioned according to group assignment with left uterine displacement.

Block height was determined using ice every 2 min until a T6 level was reached and then every minute until a T4 level was achieved. This time was recorded and surgery was then allowed to start. Routine anaesthetic management continued throughout the procedure. The block level at 30 min was recorded as maximum block height.

Fig. 1  A Control (C) Standard pillow under head. B Head Elevated Ramped Position with Troop elevation pillow (HERP). C Head Elevated Ramped Position with Troop pillow in horizontal position (HERP-H), once block established the bed was raised to be identical to position B.
Baseline systolic pressure (SBP) was recorded preoperatively and was the lowest of three SBPs taken one minute apart. An intervention blood pressure was calculated (decrease of ≥20% from baseline) and given to the attending anaesthetist as an indicator for treating hypotension. In addition, if the patient felt faint or nauseated, treatment with a vasopressor could be initiated and repeated if required. The treatment protocol consisted of phenylephrine 50–100 µg if the maternal heart rate was >80 beats/min or ephedrine 5 mg if the heart rate was <80 beats/min or managed at the discretion of the attending anaesthetist. Drugs and doses were recorded.

If block height failed to reach T4 in any group at 12 min, a 3 mL bolus from a 20 mL syringe containing 2% lidocaine 18 mL, 1:1000 adrenaline 0.1 mL and 8.4% sodium bicarbonate 2 mL was given via the epidural catheter. If the block was still inadequate after a further 3 min, further boluses of the epidural solution were given to obtain a block to T4. Before the epidural injection, the back of the bed in the HERP group was lowered so that the woman was lying horizontal to the floor, i.e., the HERP-H position (Fig. 1C).

Once an adequate block had been obtained patients in the HERP-H group or in the HERP group who were placed in the HERP-H position to ensure adequate block, were positioned in the HERP position (Fig. 1B). If surgical access was difficult due to the head elevated position, the back of the bed was lowered to position the patient horizontal.

If the block was inadequate for surgery and epidural supplementation unsuccessful, conversion to general anaesthesia was allowed. At the end of surgery the surgeon rated satisfaction with the position using a 3-point Likert scale: not satisfied, satisfied or very satisfied. Any comments related to position made by the anaesthetist, surgeon or patient were recorded. Also at the end of surgery patients were asked: “Were you satisfied with the position you were in during your operation?” using a 5-point Likert scale: strongly disagree, disagree, neutral, agree, strongly agree.

Data collected included airway assessment in ramped position, time from intrathecal injection to T4 block height, block height at 30 and 120 min, time from intrathecal injection until final position, need for epidural supplementation and the amount administered, incidence of hypotension, use of vasopressor, patient comfort at baseline in the elevated position compared to the conventional position, patient satisfaction with position during surgery and surgeon satisfaction. Other data recorded were age, height, weight, BMI, indication for CD, incision-delivery time, presence of intra-operative pain, and neonatal birth weight.

From a previous study of spinal anaesthesia at our hospital, the mean time from completing local anaesthetic intrathecal injection to surgical block was 5 min 56 s [range 2 min 9 s to 13 min 32 s]. All these patients were in the wedged supine position. Based on these data, we chose 12 min to attain a T4 block after intrathecal injection before intervening as reasonable to cover normal inter-subject variation. Our primary outcome was the time to T4 block and secondary outcomes were: inadequate block height of T4 at 12 min and need for epidural supplementation, block height at 30 and 120 min, maternal comfort, use and dosage of vasopressor and relationship of the EAM to sternal angle as an indicator of optimal head positioning for intubation.

Statistical analysis

The effect of the ramped position on the time taken to establish an effective block height has not been investigated. Most studies that have looked at position change following intrathecal block for caesarean delivery used hypotension as their primary outcome, reported time to T4 as a secondary outcome, and group sizes varied from 10 to 30 patients. A study by Inglis et al. used time to T4 block and a sample size of 40 (n = 20), a group size of 20 was chosen for the current study. This study was originally designed to detect a difference in the time to achieve a T4 block between groups. However, as the intention of the study was to determine whether the HERP or HERP-H positions increased the
time to T4 block compared with the control position, the time to T4 results were analysed using a non-inferiority analysis. In our previous study the mean time for development of T4 sensory block level to ice following intrathecal injection was just under 6 min. A difference of 3 min to achieve a T4 block (50% longer) was felt to be clinically relevant in an urgent situation.

The time to achieve a T4 block and time to adopt the study position were analysed using Kruskal–Wallis tests for non-parametric data, as there was no censoring that would necessitate a survival analysis. For the non-inferiority analysis we calculated the difference in the mean time to T4 between the control group and both HERP and HERP-H groups separately: $\text{Control}_{\text{mean}} - \text{HERP}_{\text{mean}}$ and $\text{Control}_{\text{mean}} - \text{HERP-H}_{\text{mean}}$. The 95% confidence intervals (CI) around these differences were compared to the non-inferiority margin of $-3$ min. If the CIs did not extend past $-3$ min, this indicated that the mean time to T4 of either treatment group was no more than 3 min longer on average than the Control group. Achievement of T4 block height at 12 min was compared between groups using a Fisher exact test for count data. Block height at 30 min and Likert scales for patient and surgeon satisfaction were compared between groups using a Kruskal–Wallis test. Data for EAM to sternal notch height were analysed using a McNemar test for paired categorical data. Data for comfort in the flat versus elevated positions were compared using a one-sample Wilcoxon signed-ranks test. Post-hoc tests were corrected for multiple comparisons using Bonferroni correction.

Results

Sixty women were analysed for level of comfort and airway position (Fig. 3). Six patients were excluded from further analyses (per-protocol population): two patients in the HERP group (one a failed CSE attempt who received a single-shot spinal anaesthetic, and one failed spinal component in whom the epidural was used) and four in HERP-H group (three with failed attempts at CSE who received a single-shot spinal anaesthetic, and one failed spinal component in whom the epidural was used).

The groups were similar with respect to age, BMI, parity, indication for CD, incision-delivery time, intra-operative discomfort and baby’s birth weight (Table 1).

There was no significant difference amongst the groups in time to T4 ($P = 0.14$) (Table 2 and Fig. 4). Analysing time to T4 using a non-inferiority analysis showed an overlap with the 3 min non-inferiority margin.

### Table 1 Patient characteristics

<table>
<thead>
<tr>
<th></th>
<th>Control ($n = 20$)</th>
<th>HERP ($n = 20$)</th>
<th>HERP-H ($n = 20$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>34 ± 5</td>
<td>35 ± 4</td>
<td>35 ± 4</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162 ± 7</td>
<td>161 ± 7</td>
<td>164 ± 4</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>77 ± 13</td>
<td>78 ± 14</td>
<td>80 ± 12</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>29 ± 4</td>
<td>29 ± 4</td>
<td>29 ± 4</td>
</tr>
<tr>
<td>Previous caesarean delivery</td>
<td>11</td>
<td>12</td>
<td>13</td>
</tr>
</tbody>
</table>

Data are mean ± SD or number. No significant differences between groups.

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**Fig. 3**  Consort diagram SSS: single-shot spinal; GA: general anaesthesia.
cut-off (Fig. 5), suggesting that the evidence for non-inferiority relative to the control is inconclusive. Estimates of the mean differences and the 95% CIs suggest that they could be either inferior or non-inferior to the control within a margin of 3 min.

There was a significant difference in the number of patients achieving a block height of T4 at 12 min ($P = 0.021$; Table 3). In the control group all 20 patients attained at least a T4 block by 12 min; HERP had 13 patients at T4, and HERP-H had 12 patients at T4. Supplementation of the epidural component was required in those not achieving a T4 block by 12 min. For interest, further analysis excluding these patients was performed, which again showed no significant difference between the groups for time to T4 block ($P = 0.68$) (Table 2).

There were no statistically significant differences between groups in block height at 30 min ($P = 0.21$) or 120 min ($P = 0.18$). In four patients the block height at 30 min was recorded as T5 (1 control, 2 HERP, 1 HERP-H) but only one reported discomfort and received intraoperative supplementation (HERP-H, given 2% lidocaine/adrenaline/sodium bicarbonate 5 mL). These were not the same patients who required epidural supplementation at 12 min. There was no difference in pain or discomfort throughout surgery between the groups (Table 3). No patient required conversion to general anaesthesia.

There was a significant difference among the groups in patient satisfaction ($P < 0.01$). Post-hoc Wilcoxon rank-sum tests suggest that both the experimental groups were significantly different from the control group (all Bonferroni corrected $P$ values <0.05), but not significantly different from each other ($P = 0.42$) (Fig. 6).

In all patients ($n = 60$) the level of the EAM was equal to or above the sternal notch in the HERP position, compared to only nine in the control position.

### Table 2  Time to adequate block height of T4

<table>
<thead>
<tr>
<th></th>
<th>Control ($n = 20$)</th>
<th>HERP ($n = 18$)</th>
<th>HERP-H ($n = 16$)</th>
<th>$P$ value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Including epidural top-up (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>8.2 ± 2.6</td>
<td>11.4 ± 4.6</td>
<td>10.2 ± 4.7</td>
<td>0.14</td>
</tr>
<tr>
<td>Excluding epidural top-up (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean ± SD</td>
<td>8.2 ± 2.6</td>
<td>8.8 ± 1.4</td>
<td>8.2 ± 2.1</td>
<td>0.68</td>
</tr>
<tr>
<td>Median [range]</td>
<td>7.7 [3.1–12.0]</td>
<td>9.0 [5.7–10.5]</td>
<td>7.6 [5.3–11.5]</td>
<td></td>
</tr>
</tbody>
</table>

Data are mean ± SD or median [range].
Nearly all patients (n = 58) agreed that "elocation was more comfortable than lying flat" on 5-point Likert scale. A one-sample Wilcoxon signed-ranks test suggests that the median is significantly different from 3 (no difference in comfort, V = 1711, P <0.0001).

One surgeon expressed dissatisfaction with the ramped position, but there were no significant differences in satisfaction between groups (P = 0.052).

### Discussion

This is the first study to look at the effects of the head elevated ramped position in patients receiving CSE for caesarean delivery. No significant differences in block height were found between the groups; however, due to the number of exclusions from protocol violations the sample size was small and therefore our power to detect anything but a major difference in time to T4 was low. In addition, the study protocol to administer epidural supplementation if a T4 block was not achieved by 12 min may have affected this result.

The aim of the study was to look at the effects on the time to T4 block following intrathecal injection. Gravity and patient position affect block height when using a hyperbaric agent. It was considered unethical not to use a CSE technique, since if block height was inadequate it could be raised using epidural supplementation.

The protocol stated that any failure of the CSE necessitating a single-shot spinal, or any failure of the spinal component requiring epidural supplementation would cause patients to be excluded from the study. There was a disappointingly high number of failed CSE (six patients), which may reflect the preference for single-shot spinal anaesthesia rather than CSE by some anaesthetists at our hospital. There were no failures in the control group; one reason may be that unfamiliarity with the CSE technique combined with an unfamiliar position led to a higher failure rate in the non-control groups. These exclusions reduced the sample size further, and reduced the power of the study.

The need for epidural supplementation may have been reduced if longer than 12 min had been permitted before its use, but as this was a clinical study an intervention time was needed to ensure smooth running of the scheduled operating schedule. Using non-inferiority analysis and including those patients with epidural supplementation showed that both HERP and HERP-H were possibly inferior to the control position, but the evidence was inconclusive. Larger sample sizes are needed to provide conclusive evidence of either inferiority or non-inferiority.

The inclusion of the HERP-H group was an attempt to mitigate the effects of position on establishment of adequate block; one concern raised before starting the study was that the block would not rise as high in the ramped position as in the control group. Therefore we chose to add a third group where the patient would be in a supine position on the elevation pillow following intrathecal injection, and only elevated once an adequate block height had been achieved. The effects of gravity would be the same as the control group and the benefits of comfort, breathing and airway position offered by the head elevated position could then be provided once an adequate block height had been achieved.

Block height at 30 min was intended to represent maximum block height achieved, and yet four patients reported block heights of T5 at that time. It may be that this apparent one dermatome regression at 30 min was due to surgery being in progress with block height measured under the surgical drapes which may have been inaccurate.

### Table 3 Secondary Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 20)</th>
<th>HERP (n = 18)</th>
<th>HERP-H (n = 16)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T4 block height at 12 min</td>
<td>20 (100%)</td>
<td>13 (72%)</td>
<td>12 (75%)</td>
<td>0.021</td>
</tr>
<tr>
<td>Block height at 30 min</td>
<td>T2 [C5-T5]</td>
<td>T3 [C6-T5]</td>
<td>T2 [T1-T5]</td>
<td>NS</td>
</tr>
<tr>
<td>Block height at 120 min</td>
<td>T4 [T2-T7]</td>
<td>T5 [T2-T8]</td>
<td>T6 [T2-T8]</td>
<td>NS</td>
</tr>
<tr>
<td>Time to position patient (min)</td>
<td>1.9 [0.6–2.4]</td>
<td>1.7 [0.8–5.0]</td>
<td>2.4 [1.3–7.1]</td>
<td>NS</td>
</tr>
<tr>
<td>Intraoperative discomfort</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>NS</td>
</tr>
<tr>
<td>Vasopressor use</td>
<td>15 (75%)</td>
<td>12 (67%)</td>
<td>13 (81%)</td>
<td>NS</td>
</tr>
<tr>
<td>Patients given &gt;10 mg ephedrine or 100 μg phenylephrine</td>
<td>8/15 (53%)</td>
<td>6/12 (55%)</td>
<td>3/13 (25%)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Data are number (%), median [range].

(P < 0.01). Nearly all patients (n = 58) agreed that “elocation was more comfortable than lying flat” on 5-point Likert scale. A one-sample Wilcoxon signed-ranks test suggests that the median is significantly different from 3 (no difference in comfort, V = 1711, P <0.0001). One surgeon expressed dissatisfaction with the ramped position, but there were no significant differences in satisfaction between groups (P = 0.052).
When comparing the effects of the lateral versus supine position for insertion of neuraxial anaesthesia, Loke et al. demonstrated a reduced incidence of hypotension immediately following spinal injection in patients placed in a 10 degree head-up position. Our study used a greater angle of elevation, but did not provide evidence to support a difference in the incidence of hypotension or vasopressor use.

Patients in the HERP-H group were horizontal until adequate block height had been achieved, and it was expected that their time to T4 would be closer to the control group times. It became apparent that lack of familiarity with the ramped position and the need to manipulate the operating table may have led to HERP-H patients being more upright than planned which may have affected block height.13,14

The ramped position was significantly more comfortable for the parturient. It was not possible, however, to blind the operating surgeon from the position. Most surgeons did not notice any difference, but one was unhappy with the position. Caregivers concerns about the use of the HERP position were not found.

Although it cannot be shown that positioning of the parturient in the elevated position reduces the incidence of failed intubation, it improved the relationship between the EAM and sternal notch. Unanticipated need for intubation may occur at any point during surgery in the parturient. Consideration should be given to placing all parturients in this position, even if a neuraxial technique is planned. We would advise waiting until a T4 block is established before elevation. Obese parturients were excluded from the study because body mass can affect the height of block, although studies have shown the benefits of the head elevated position for general anaesthesia in obese patients.2

Whether this study is generalizable to using the ramped position following a single-shot spinal anaesthetic is unknown; further work with a larger sample size is advised. However, it is the first author’s practice to position women in a head elevated ramped position once a good bilateral T4 block has been established.

In conclusion, we found that use of the HERP or HERP-H did not significantly delay time to T4 block in parturients undergoing elective CD under CSE, and patient satisfaction was higher in these positions when compared to control. However, the need for supplementation was greater in the intervention groups, and caution is advised in adopting this position immediately following intrathecal injection. Therefore, we recommend that parturients be elevated into the ramped position only after appropriate block establishment, thereby achieving the benefits without potentially delaying surgery.

Disclosure

Joanne Douglas is an Editor of IJOA; however, she had no involvement with the editorial process or decision to accept the manuscript for publication. The authors received no financial support and have no conflicts of interest to declare.

References