SPINAL ANAESTHESIA FOR CAESAREAN SECTION

The use of 0.5% bupivacaine

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SUMMARY

Subarachnoid anaesthesia was induced with 0.5% bupivacaine 2–3.5 ml in 33 women scheduled for elective Caesarean section. Three patients failed to develop adequate analgesia with bupivacaine but were managed satisfactorily with heavy cinchocaine. All the other patients developed adequate analgesia eventually. Since the spread of analgesia was uniquely dependent on posture a new hypothesis is presented to explain the distribution of intrathecal anaesthetic drugs in late pregnancy.

The isobaric property of certain local analgesic agents may be advantageous in subarachnoid anaesthesia since the extent of blockade is reputed to be independent of posture and, in some instances, the patient has been positioned for surgery before institution of the blockade (Henschel et al., 1967). Thus, in theory, the use of a solution which is unaffected by gravity may enable a pregnant patient to lie on her side until adequate blockade has been achieved and any systemic hypotension corrected before she is positioned for surgery. Any subsequent decrease in arterial pressure would most probably be a result of aorta–caval compression and could be treated appropriately. However, the major disadvantage of isobaric solutions in subarachnoid anaesthesia is their unpredictability (Moore, 1965). Nevertheless, if the patient remained on her side with the needle in situ the block could be extended by a “top-up” increment of local anaesthetic, thus removing some of the uncertainty associated with a single injection technique.

Results are presented from a study of subarachnoid anaesthesia with 0.5% bupivacaine in 33 patients undergoing elective Caesarean section.

PATIENTS AND METHODS

All women who wished to be awake during their elective Caesarean section were given a detailed explanation of the procedure and their consent obtained. In the operating theatre, they lay in the left lateral position breathing oxygen 6 litre min⁻¹ via a Hudson mask, while a fluid load was administered i.v. over 5–10 min. Early in the series Hartmanns solution 1000 ml was administered, while later in the study Haemaccel 500 ml was given in addition.

The women were divided into three groups and studied sequentially. Group I (n = 10) received 0.5% bupivacaine 3–3.5 ml intrathecally, and then lay on their sides for 10–15 min. The blockade was inadequate at this time, and they each received a further increment of bupivacaine 0.5–1.5 ml through the same needle, which had not been removed.

Five minutes later the patients were turned supine with a wedge under the right hip.

Group II (n = 10) also received 0.5% bupivacaine 3–3.5 ml into the subarachnoid space and lay on their sides for 10–15 min. They were then turned supine onto the wedge.

Group III (n = 13) received 0.5% bupivacaine 2–3 ml intrathecally and were placed on the wedge within 1 min of the injection.

The subarachnoid needle was inserted through the L2/3 space in the majority of the patients, although in three patients in each of groups I and III the needle was inserted via the L3/4 space. Analgesia was assessed by pinprick at 5-min intervals, 5 cm on either side of the midline, and down each arm if necessary. In patients in whom analgesia favoured one side, the higher of the levels was used for statistical purposes.

RESULTS

One woman in each group failed to develop adequate analgesia to pinprick despite, in one patient, a further bupivacaine 1.5 ml. These patients subsequently developed adequate analgesia following heavy cinchocaine (Nupercaine) 1.5 ml.

In group I (fig. 1) none of the patients developed adequate analgesia while lying on her side. Follow-
increment of bupivacaine

* positional change

**FIG. 1.** Analgesic levels (± standard error of mean) immediately, and 5 min, before an increment of bupivacaine, 5 min after this increment and the final level after positioning on a wedge for surgery. All patients on their side initially.

**FIG. 2.** Analgesic levels (± standard error of mean) immediately and 5 min before being positioned supine on a wedge, 5 min after this positional change and the final level attained after positioning (group II). All patients on their side initially.
ing an increment of bupivacaine there was a small but significant increase in the level of analgesia ($P < 0.0001$). There was a significant and more marked cranial spread of analgesia following positioning ($P < 0.0001$). Likewise in group II (fig. 2), none of the women developed adequate analgesia while lying on her side. However, 5 min after repositioning there was a significant increase in the level of analgesia ($P < 0.0001$). There was a further, more modest, increase to the final value, but this was not significant. In group III (fig. 3) the level of analgesia spread cranially rapidly despite the administration of smaller doses of bupivacaine.

In seven patients analgesia was two or more segments higher on the upper side (two in group I, four in group II and one in group III). These differences either disappeared on repositioning or were not a problem clinically because of the high levels of analgesia. Analgesia in the patient in group III reached T5 on the right side and T10 on the left side at 10 min. She was immediately turned onto her right side for 1 min and then replaced on the wedge. By 15 min her analgesia was at its highest level—T3 on both sides.

Seven patients in each group (64%) became hypotensive (systolic arterial pressure less than 100 mg Hg); the arterial pressure decreased in six while they were lying on their sides (three in group I and three in group II).

The frequency of headache was 24% (eight women); in three patients this was of short duration. In the other patients the headache did not occur until the next day (two patients); the 2nd day (one patient); the 3rd day (one patient); and the 4th day (one patient). These five patients were all successfully treated with a blood patch using 20 ml of autologous blood.

**DISCUSSION**

These results emphasize the small volume of bupivacaine required for Caesarean section when the analgesic is administered into the subarachnoid space. This is in contrast to work by Chambers, Edstrom and Scott (1981) who found bupivacaine 3 ml unsuitable for major gynaecological surgery. However, Henschel and colleagues (1967) found that only half the usual dose of isobaric mepivacaine was required for vaginal delivery when compared with perineal procedures in other patients, and Russell (1982) demonstrated a rapid onset of analgesia and a high level of block (T7 at 5 min and a final mean level of C7) when bupivacaine 3 ml was administered during labour.

The maximum mean level of analgesia in this study (for all groups) was T3, which was considerably higher than levels found in non-pregnant patients (table I). However, during the time the patients lay on their sides the analgesia was limited: the level of analgesia at 10–15 min was T10 (mean value for groups I and II combined). This compares with levels of T12 (Chambers, Edstrom and Scott, 1981), T8 (Nolte and Starke, 1979) and above T10 (Cameron et al., 1981) observed at a similar time in non-pregnant patients turned supine soon after injection. All these authors noted that, at this time (10–15 min after the original injection), the level of analgesia was within one to three segments of its final level, although in some instances the spread

<table>
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<th>Authors</th>
<th>Volume of 0.5% bupivacaine (ml)</th>
<th>Mean maximum level</th>
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<tbody>
<tr>
<td>Nolte and Stark (1979)</td>
<td>3</td>
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<td>Nolte and others (1977)</td>
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<td>Chambers, Edstrom and Scott (1981)</td>
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continued gradually for up to 30 min. This slow and somewhat limited extension of analgesia probably represents simple diffusion and is quite unlike the rapid spread occurring when the women in this study were repositioned. In group III by 15 min the height of analgesia was within one segment of its final level (fig. 3).

The tendency for analgesia to favour the upper side indicates that 0.5% bupivacaine is slightly hypobaric in some patients. This particular finding, in a patient in group III, was surprising considering the small degree of tilt involved. A unilateral analgesic tendency appears even more marked with 0.75% bupivacaine (unpublished results) and it is the writer's policy to induce spinal anaesthesia with the patient lying on her right side, before repositioning her with the wedge under her right hip (Sprague, 1976).

It is evident that the act of placing these patients in the supine position with a wedge under the right hip caused a change in cerebrospinal fluid (CSF) dynamics. It is believed that a decrease in CSF volume in the spinal canal is the explanation for the high levels of spinal analgesia obtained in late pregnancy, the decrease being secondary to chronically engorged veins within the extradural and subarachnoid spaces (Green, 1981). There is, however, no direct evidence of a decrease in volume since CSF volume has not been measured in pregnancy (Green, 1981). One argument against this theory is the observation by Marx, Zemaitis and Orkin (1961) that there is no change in CSF pressure when it is measured immediately before, and after, delivery despite a rapid decrease in femoral venous pressure. On account of the relative inelasticity of the subarachnoid space a sudden decrease in CSF pressure would be expected since, in the acute period studied, CSF production could not have compensated for the sudden removal of blood from the engorged extradural and subarachnoid veins. In the present study, simple diffusion of bupivacaine would be too slow to cause the sudden increase in the levels of analgesia which were found after positioning the patient, and the fact that analgesic levels were virtually stationary before turning the patients, suggests that volume displacement from the original injection had ceased. The volume of CSF must also have remained constant in the few minutes which elapsed between turning the patient and the assessment of the height of the analgesia. The only explanation for this rapid spread of analgesia is the physical movement of CSF, containing bupivacaine, from the caudal end of the subarachnoid space towards the upper thoracic and cervical regions. This displacement would require some degree of capacitance in the inelastic subarachnoid space of the upper thoracic and cervical regions. The following hypothesis on CSF dynamics is proposed to unite the “reduced CSF volume” point of view with the contradictory pressure studies of Marx, Zemaitis and Orkin (1961) and, at the same time, explain the behaviour of the bupivacaine in this study.

When a pregnant patient is turned into a supine position (even onto a wedge) some degree of caval occlusion may occur acutely. The sudden diversion of blood into the vertebral venous system will decrease the available CSF volume at the caudal end of the subarachnoid space, thus moving CSF in a cranial direction before the advancing front of engorged veins. Barclay, Renegar and Nelson (1968) observed this movement during myelography when abdominal compression obstructed the inferior vena cava. They showed also that, when a pregnant patient assumed the supine position, although there was a sustained increase in pressure in the inferior vena cava there was only a temporary increase in CSF pressure, that is, there was considerable compliance within the system. The capacitance required to accept this displaced CSF could conceivably be obtained by a decrease in the venous volume of the cervical and upper thoracic extradural and subarachnoid spaces and possibly even the intracranial venous volume. Changes in intracranial venous volume are known to occur and compensate for acute increases in intracranial pressure (Turner and McDowall, 1976). By this mechanism changes in vertebral venous volume at one end of the space could be rapidly compensated for with no significant change in CSF pressure. Thus, whenever femoral venous pressure increases, whether as a result of pregnancy, other space occupying lesion, or abdominal binders (Barclay, Renegar and Nelson, 1968), engorgement of the veins in the lower subarachnoid and extradural spaces displaces CSF in a cranial direction and decreases CSF volume in the lumbar subarachnoid space. In the present study the presumed caval occlusion occurred during development of the block and could thus account for the limited spread initially being followed by a sudden extension of analgesia on repositioning.

Nausea, usually but not always, associated with hypotension, was the most troublesome side-effect. The frequency of hypotension (64%) in this series agrees with the findings of Clark, Thompson and
Thompson (1976), who noted that 53% of their patients became hypotensive despite a 1-litre crystalloid preload and uterine displacement. In contrast, Wollman and Marx (1968) found that a 1-litre crystalloid preload prevented systemic hypotension even with a cutaneous block to T2. They found also that a fluid load after institution of the subarachnoid block was much less effective. This may be the reason for the high frequency of hypotension in groups I and II since, unless it was a difficult arachnoid puncture, the injection was frequently given before the full litre of fluid had been administered. However, over half of the instances of hypotension occurred following repositioning, by which time either 1.5–2 litre of crystalloid or 1 litre of crystalloid plus 500 ml Haemaccel had been given. In group III all patients received 1 litre of crystalloid and 500 ml of Haemaccel before institution of the block with little obvious advantage. This lack of effect could be caused by the very rapid change in haemodynamics which must accompany subarachnoid anaesthesia in these patients. Once hypotension developed it was difficult to treat with fluid alone, especially if only crystalloid was used. Since patients in whom several litres of crystalloid were administered found the increase in urine output inconvenient, the later patients received Haemaccel as part of the fluid pre-load and ephedrine (6-mg increments) for hypotension.

The frequency of headache was 15% (or 24% depending on the aetiology of the three cases with short-lived headaches). This is in reasonable agreement with Chambers, Edstrom and Scott (1981) who found a frequency of 20% in their "young" population (average age 45 yr). The average age in this study was 28 yr. Five patients were successfully treated with a blood patch, and all were pleased with the increase in mobility since, although bed rest is undoubtedly effective in preventing headache, the patients disliked the enforced immobility.

Some may cast doubt on the validity of these findings as the trial was not randomized. However, it was as the results of group I became available that it became evident that either the increment of bupivacaine or the change in posture was having a marked effect. To differentiate between these two factors, the increment was omitted in group II. Since the results in group II showed unequivocally that posture was the important factor in promoting the spread of analgesia, the patients in group III were turned immediately. Their results emphasize the importance of posture. Thus, it would appear that, during subarachnoid analgesia in late pregnancy, physical movement of the CSF is probably the principal reason for the high levels of analgesia.

In conclusion, 0.5% bupivacaine 3 ml provided adequate levels of analgesia for Caesarean section provided the patient was placed supine on a wedge soon after the intrathecal injection. The "top-up" principle described in the introduction was of limited value and had it been continued until upper thoracic dermatomes were analgesic it is conceivable that total spinal anaesthesia could have occurred rapidly on turning the patients to the supine position.

REFERENCES
RACHIANESTHESIE POUR CESARIENNE
Utilisation de la bupivacaine a 0,5%

RESUME
Chez 33 patientes devant subir une Césarienne réglée, une rachianesthésie a été effectuée avec 2-3,5 ml de bupivacaine à 0,5%. Chez trois patientes, on n’a pas réussi à obtenir une analgésie suffisante avec la bupivacaine, mais ces patientes ont pu être traitées de façon satisfaisante par la cinchocaine hyperbare. Chez toutes les autres patientes, une analgésie correcte a pu être obtenue. Dans la mesure où la diffusion de l’analgésie ne dépend que de la posture, une nouvelle hypothèse est proposée pour expliquer la distribution des agents anesthésiques par voie sous-arachnoïdienne pendant la dernière partie de la grossesse.

SPINALANÄSTHESIE BEIM KAISERSCHNITT
Anwendung von 0,5 %igem Bupivacain

ZUSAMMENFASSUNG
Bei 33 Frauen, die für einen elektiven Kaiserschnitt vorgesehen waren, wurde mit 2 - 3,5 ml 0,5 %igem Bupivacain eine subarachnoidale Anästhesie eingeleitet. Drei Patientinnen entwickelten mit Bupivacain keine adäquate Analgesie, wurden jedoch mit schwerem Cinchocain zufriedenstellend analgetisiert. Alle anderen Patientinnen entwickelten eine schließlich ausreichende Analgesie. Da die Ausbreitung des analgetischen Bereichs einzig von der Körperstellung abhängt, wird eine neue Hypothese zur Erklärung der Verteilung intrathekaler Anästhetika in der Spät Schwangerschaft angeführt.

ANESTESIA ESPINAL PARA OPERACIÓN CESÁREA:
El uso de bupivacaina al 0,5%

SUMARIO
En 33 mujeres que estaban al punto de tener una operación cesárea electiva, se indujo una anestesia subaracnoidea con 2 - 3,5 ml de bupivacaina al 0,5%. Tres pacientes no obtuvieron una analgesia apropiada con la bupivacaina, pero se les dio una analgesia satisfactoria con una fuerte dosis de cinchocaina. Todas las demás pacientes obtuvieron una analgesia adecuada. Puesto que la difusión de la analgesia dependía únicamente de la postura, se presenta una nueva hipótesis para explicar la distribución de las substancias anestéticas intratecales en la última fase del embarazo.