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Lateral recumbent head-down posture for epidural catheter insertion reduces intravascular injection

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Purpose: The unintentional and unrecognized cannulation of an extradural vein is a potentially serious complication of an epidural anesthetic. The present study was undertaken to assess the incidence of blood vessel puncture related to epidural catheterization performed in three different body positions. –

Methods: The study was conducted in 900 (three groups of 300) obstetric patients undergoing continuous epidural analgesia during their labour and who were randomly allocated to three groups. Epidural catheterization was performed with patients in the sitting, lateral recumbent horizontal, or lateral recumbent head-down position.

Results: There was a lower incidence of vessel cannulation when this procedure was performed in the lateral recumbent head-down position (2%) than in the lateral recumbent horizontal (6%) and in the sitting position (10.7%).

Conclusion: Adoption of the lateral recumbent head-down position for the performance of lumbar epidural blockade, in labour at term, reduces the incidence of lumbar epidural venous puncture.

Objectif : La canulation accidentelle et passée inaperçue d'une veine péridurale représente une complication potentiellement dangereuse de l'anesthésie épidurale. La présente étude évalue l'incidence de ponction vasculaire reliée au cathétérisme péri-dural réalisé selon trois positions corporelles différentes.

Méthode : L'étude a été menée auprès de 900 patientes en obstétrique, trois groupes de 300 réparties au hasard, qui recevaient une analgésie épidurale pendant le travail. La mise en place d'un cathéter péri-dural a été réalisée en position assise, allongée sur le côté ou allongée sur le côté et tête vers le bas.

Résultats : L'incidence de ponction vasculaire est plus faible, 2 %, en position allongée avec la tête vers le bas, puis de 6 % en position allongée sur le côté et de 10,7 % en position assise.

Conclusion : Pendant le travail dans le cas d'une grossesse à terme, l'adoption de la position allongée sur le côté et tête vers le bas, pour l'administration d'un bloc épidural, réduit l'incidence de ponction veineuse.

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MANY reports attest to the concern which anesthesiologists feel about the hazard of accidental and unrecognised cannulation of an epidural vein during an extradural anesthesia. Patients who have been given unintentional intravascular injections of anesthetic doses of potent lipid soluble, protein bound, amide local anesthetic agents, such as bupivacaine, have suffered cardiovascular collapse and convulsions.¹⁻⁴ The search for techniques to reduce the incidence of this iatrogenic mishap continues.

A previous study found that maternal posture, sitting or lateral, had no effect on the ease of insertion of epidural catheters for analgesia in labour, or the complication rate, including vessel puncture.⁵

Our study was undertaken to assess the incidence of blood vessel puncture related to epidural catheter insertion in three different body positions, sitting, lateral recumbent horizontal, and lateral recumbent head-down, in obstetric patients undergoing continuous epidural analgesia during their labour.

The rationale for assuming that a head-down tilt in the lateral recumbent position would reduce the incidence of venous puncture is that the rich plexus of veins filling the lumbar epidural space, dilated secondary to chronic vena canal compression by the gravid uterus in late pregnancy, would be less engorged and dilated with the patient in the head-down, left lateral recumbent position and therefore less likely to be punctured either by the epidural needle or by the catheter itself. To the best of our knowledge no such study has been previously undertaken and published.

The reported incidence of blood vessel puncture after placement of a needle and catheter into the lumbar epidural space, in obstetric practice, appears to vary between 1 and 10%.^{6,7} The frequency of intravascular injection during epidural anesthesia in all patients varies from 0.2% to 11% with a typical frequency of 2%,⁸ and in obstetric patients with a higher frequency of 7-8.5%.^{9,10} Vessel entry and intravascular injection can occur on initial insertion of the epidural needle, or when the epidural catheter has been inserted before the injection of the local anesthetic agent in an incidence of up to 9%.^{4,11}

The search for symptoms of central nervous system irritability produced by sub-toxic doses of local anesthetics has been recommended as an indicator of unintentional intravascular injection. These symptoms include tinnitus, peri-oral tingling, a metallic taste, dizziness, sedation and alteration of hearing after a 3 ml test dose of lidocaine 2% without adrenaline.¹²⁻¹⁴

Materials and methods

This study was approved by the local Human Investigation Committee of the Assaf Harofeh Medical Center. Written, informed consent was also received from all the patients who received continuous epidural analgesia during their labour and who participated in this study of three different techniques in the method of epidural catheter insertion.

Nine hundred healthy parturient women, aged between 18 and 45 yr, in the first stage of labour, in the obstetric unit of the Assaf Harofeh Medical Center, during the period 1996 to 1999 were randomly allocated into the three study groups. Patients with pre-existing pre-eclampsia, cardiovascular disease (congenital and/or rheumatic), and patients with morbid obesity, defined as those with a body mass index > 35 [BMI = weight kg/height² (meters)] were excluded from the study.

Every patient received an *iv* infusion of 1000 ml of saline 0.9% solution before the procedure. The 900 parturients were randomly assigned to three groups, consisting of 300 patients each. The procedure of epidural puncture and catheter insertion was performed with the patient on an adjustable obstetric bed, capable of being tilted by an electric motor to any particular angle required – horizontal, Trendelenburg or anti-Trendelenburg positions, respectively.

In all 900 patients, maternal heart rate and blood pressure were monitored and recorded electronically by an automated device using periodic cuff inflation and deflation at cycle times three minutes apart, throughout the procedure. An ultrasonographic device monitored the fetal heart rate and uterine activity was monitored by a tocodynamometer.

All blocks were performed by experienced anesthesiologists only, all of whom had worked in obstetric anesthesia for at least 15 yr, and all of whom were experienced in the performance of epidural blocks in both the sitting and lateral recumbent positions, respectively.

Group 1 (300 patients): The epidural puncture and the catheter insertion were performed with the patient in the sitting position with her hips and knees flexed and the soles of her feet resting on a stool and with her lumbar spine flexed.

Group 2 (300 patients): The epidural puncture and the catheter insertion were performed with the patient lying in the left lateral position with her hips and knees flexed, her lumbar spine flexed and with the operating table in the horizontal position.

Group 3 (300 patients): The epidural puncture and the catheter insertion were performed with the patient lying in the left lateral position with her hips and knees

flexed, lumbar spine flexed and with the operating table placed in a 25-30° head down position. The 25-30° head down angle was established using an architect's plastic 30° angled triangle (Rotring Primus* protractor).

In all three groups throughout the study, a Portex Minipack epidural system was used. This contains an 18G Tuohy epidural needle, a radio-opaque epidural catheter with a blunt end and three helically placed side-holes near the catheter tip, and a disposable plastic syringe assembly (SIMS PORTEX Ltd., Hythe, Kent CT21 6JL, U.K.). After securing local anesthesia of the skin and supraspinous ligament with lidocaine 2%, the Tuohy needle was inserted in either the 2nd or 3rd lumbar interspace by the mid-line approach, and with the needle orifice directed cephalad. In each patient the epidural space was identified by the loss of resistance test using an air-filled plastic syringe.

In no patient was the needle insertion or catheter threading performed during a uterine contraction. After identifying the epidural space and in the absence of blood or CSF at the needle's hub, the catheter was threaded through the needle to a depth of 4 cm beyond the distal needle orifice and the needle was withdrawn over the catheter. The catheter was then withdrawn so that a calculated 3 cm length of catheter remained in the epidural space. The patient was allowed to assume the normal lumbar lordotic position and the catheter was then fixed to the skin by tape.

Any free flow of blood at the needle hub prior to the catheter insertion was regarded as evidence of blood vessel puncture. When this happened the needle was removed and inserted into the adjacent interspace and the catheter again threaded through the needle at that level. In the absence of free blood or CSF flowing through the catheter, the catheter was then gently aspirated and examined for the presence of blood or CSF. Should the needle or catheter insertion be accompanied by blood in the needle or catheter, the needle and catheter assembly were withdrawn, and the procedure repeated at another interspace more cephalad. Should the final catheter insertion be accomplished without evidence of venous cannulation, and after fixation of the catheter to the skin with Transpore tape (3 M Health Care, St. Paul MN 55144-1000, U.S.A.) all patients were placed in the left lateral recumbent position. In Group 3, the obstetric bed was returned to the horizontal position. A 3 ml test dose of lidocaine 2% (60 mg) was then injected through the catheter and the patient observed for five minutes for the development of sensory blockade changes in the L₂ or lower dermatomes, or inability to move the toes, as evidence of an unintentional

subarachnoid injection. At the same time, the patient was also assessed for symptoms of central nervous system irritability produced by subtoxic doses of the lidocaine that were used as an indicator of unintentional intravascular injection.¹²⁻¹⁴ In the absence of any indication of intravascular or subarachnoid puncture, 8 mL bupivacaine 0.25% were then slowly injected through the epidural catheter to provide analgesia during the 1st stage of labour. Subsequent top-up doses of 8 mL bupivacaine 0.25% were administered according to need, and ultimately, top-up doses of 10 mL bupivacaine 0.125% were administered close to the onset of the second stage of labour.

Statistical analysis

The primary outcome in this trial was the occurrence of blood in the epidural catheter, as this is the most serious of the complications that were our subject of investigation. Other related variables (blood on the needle puncture, inadvertent subarachnoid puncture, and more than one attempt at epidural cannulation) were considered secondary outcomes.

Statistical tests were carried out on the three pairwise differences (Sitting (S) vs Lateral Horizontal (LH) position, S vs Lateral Head-Down (LHD) position, and LH vs LHD position) in incidence rates of the primary outcome, using Pearson's Chi-Square test with Yates' continuity correction. The Tukey-Kramer procedure was used to correct for the multiple comparisons.¹⁵ This led to raising the 5% critical level for the test from 3.84 to 5.48. Thus, all chi-squared results greater than 5.48 were considered as significant at the 5% level ($P < 0.05$).

The same criterion was used to test also for differences in the secondary outcomes, although these tests are to be regarded as more informal searches for the effects on the rates of other complications of epidural analgesia.

Results

The occurrences of the primary outcome, accidental intravascular cannulation, and the secondary outcomes, blood vessel puncture, unintentional subarachnoid puncture and the number of patients requiring more than one attempt at epidural cannulation in each of the three groups of patients treated in the three different positions – sitting, lateral recumbent horizontal, and lateral recumbent head-down, 25 - 30°, are shown in the Table.

The incidence of unintentional vessel puncture by the epidural catheter (the primary outcome) was less with the patient in the lateral recumbent, head-down position (2.0%), than in the sitting position (10.7%) (P

TABLE Complications in performance of epidural analgesia – the effect of three different patient positions.

<i>Patients</i>	<i>Position</i>	<i>Blood in epidural catheter</i>	<i>Blood on needle puncture</i>	<i>Inadvertent subarachnoid puncture</i>	<i>More than 1 attempt at epidural cannulation</i>
300	Sitting (S)	32 (10.7%)	6 (2%)	2 (0.7%)	40 (13.3%)
300	Lateral recumbent horizontal (LH)	18 (6.0%)	4 (1.3%)	3 (1.0%)	24 (8.0%)
300	Lateral recumbent head-down (LHD)	6 (2.0%)	1 (0.3%)	1 (0.3%)	21 (7.0%)
900	Total	56 (6.2%)	11 (1.2%)	6 (0.7%)	85 (9.4%)
Pairwise	S v LH	3.68	0.10	0.00	3.94
Tests †	S v LHD	17.56*	2.31	0.00	5.91*
(Chi-square)	LH v LHD	5.25	0.81	0.25	0.1

† the chi-square test is not strictly suitable for the comparisons in the second and third columns where the numbers of complications are small. However, apart from the first column, the comparisons are informal and the test results provide a rough guide only.

* exceeds the critical level 5.48 derived from the Tukey-Kramer pairwise comparison procedure

< 0.05). The incidence was also numerically lower in the lateral horizontal position (6.0%) than in the sitting position (10.7%), but the difference did not attain statistical significance ($P > 0.05$). Among the secondary outcomes, the number of patients requiring more than one attempt at epidural cannulation was higher in the sitting position (13.3%) than in either of the two lateral recumbent positions (8.0% for lateral horizontal, 7.0% for lateral head-down), partly due to the increased incidence of blood in the epidural needle or blood in the epidural catheter in the sitting position. The difference between the sitting and lateral head-down positions attained statistical significance ($P < 0.05$). The other secondary outcomes showed a similar trend towards higher rates in the sitting position and lower rates in the lateral head-down position, but the differences were not statistically significant ($P > 0.05$).

In only one case (a parturient in the lateral recumbent horizontal LH group), using the cannulation technique described above, did we encounter a negative aspiration test after catheter insertion, and then subsequently found the catheter to have been placed intravenously.

In the present study there were no significant differences in block height between the groups, nor in maternal hemodynamic responses nor in neonatal outcome.

Discussion

The results of our study showed reduction in epidural venous cannulation when the procedure was performed in the lateral recumbent head-down position.

In the study by Stone *et al.*⁵ which addressed these same concerns in a prospective, randomized group of 144 mothers in labour, and in a subsequent non-randomized group of 152 parturients, these authors con-

cluded that while the sitting position offered some superiority over the lateral recumbent in terms of technical ease of needle and cannula insertion, there was no difference in complication rates or maternal discomfort between the two positions in either study period. In their randomized group, evidence of blood vessel puncture in the sitting position was 18%, and 12% in the lateral recumbent group; in the non-randomized group, where the position of the patient was chosen according to the preference of the individual anesthesiologist, the incidence of blood vessel puncture was 8% in the sitting position and 4% in the lateral recumbent position. They commented that although the increased incidence of blood vessel puncture in the sitting position did not achieve statistical significance, it would seem likely that in the sitting patient, the increased epidural venous pressure would increase the incidence of vessel puncture. This comment and explanation of Stone *et al.* is in accord with the results obtained in our study. However, they also commented that an anesthesiologist unaccustomed to using the lateral recumbent position was more likely to encounter difficulty in identification of the mid-line, resulting in a greater risk of blood vessel puncture than in the case of an operator experienced in, and preferring, the lateral position.

In our study we did not measure or record the effect of patient position on the ease of catheter insertion, time for placement, or difficulty in identifying the mid-line. However, we had the impression that the majority of patients felt more comfortable in the lateral recumbent position. The majority of the anesthesiologists preferred the sitting position and, although not measured, the overall impression of the participating anesthesiologists was that the time for catheter placement was shorter in the sitting position than in the lateral recumbent.

The study of blood vessel puncture during epidural anesthesia by Verniquet,⁴ demonstrated the beneficial effect of the injection of fluid via the needle before inserting the catheter. With the patient in the lateral position, he injected 10 ml plain bupivacaine 0.5% into the epidural space prior to catheter insertion and this resulted in an incidence of blood vessel puncture of 3% compared with an incidence of 9% after direct catheter placement. We think that this practice may have both merit and logic and while it was not employed in the protocol in our study, it deserves wider attention, provided that this fluid be normal saline and not bupivacaine. This step would then not interfere with the subsequent test dosing for intrathecal catheter placement, nor for the detection of paresthesia due to intravascular injection of local anesthetic.

The reliability of the test dose to determine intravascular placement of the epidural catheter and the optimal composition of the test dose in labouring women have been the subject of considerable controversy.^{9,14,16}

The recent report on whether the epinephrine test dose improves the diagnostic accuracy of aspiration of the epidural catheter during labour epidural analgesia,¹⁷ the editorial comment on this study,¹⁸ and subsequent correspondence – all by equally experienced workers in this field,¹⁹ all serve to highlight the controversy and lack of consensus surrounding this topic.

All, however, agree that no single test dose is perfect, that there are several different ways to test a catheter for *iv* placement and that “there is no substitute for careful observation, vigilance and sound clinical judgement”.^{18,19}

As an alternative, an air test in which 1 ml of air is injected into the catheter with precordial Doppler detection was proposed in 1990 as a clinically useful indicator of an intravenously placed epidural catheter.²⁰ In their study these authors reported an apparent sensitivity and specificity greater than 90% – a figure higher than that for the test dose of lidocaine or lidocaine with epinephrine in a parturient in labour.

At the time that our study was commenced we were not aware of the greater reliability of the air test, and for this reason it did not form part of the protocol in our series. However, we intend to incorporate it in a further series of epidural analgesia procedures in different patient positions.

The unrecognised, unintentional intravascular injection of local anesthetics has been stated to be the most important hazard of epidural blockade and is more likely with epidural anesthesia than with other regional anesthetic techniques because of the rich plexus of veins filling the epidural space.¹⁶ These ves-

sels, the so-called valveless veins of Batson,²¹ are dilated secondary to the chronic vena caval compression by the gravid uterus, with a resulting increase in epidural venous blood flow.

From our study, it would appear that in the parturient close to term or in labour, there are advantages in inserting the epidural needle and thereafter the epidural catheter, in the lateral recumbent 25 head-down position, in order to reduce venous congestion in the epidural veins and thereby minimize the incidence of epidural vessel puncture or venous cannulation.

The possible role of the type of catheter used on the incidence of epidural vein cannulation deserves consideration. The less rigid Arrow Flextip epidural catheter may well have a reduced tendency to puncture an epidural vessel²² compared with the Portex epidural catheter used in our study.

The effect of head-down tilt position on maternal hemodynamics has not been well investigated. One study showed that mean arterial blood pressure did not change in response to 10 head-down tilt for 30 min in pregnant subjects, but it was increased in non-pregnant control subjects. Heart rate remained unchanged in both pregnant and non-pregnant healthy subjects, but decreased in preeclamptic patients.²³ Head-down tilting has been successfully used to prevent hypotension in patients undergoing elective Cesarean section under spinal anesthesia with hyperbaric bupivacaine 0.5%.²⁴ However, a more recent study showed that a 10 head-down position had no effect on the incidence of hypotension during spinal anesthesia for Cesarean delivery.²⁵ The Trendelenburg position with epidural anesthesia has also been suggested as a safe method in pregnant patients with severe mitral stenosis, undergoing emergency Cesarean section because of the potential for hemodynamic deterioration. Pulmonary capillary wedge pressure (PCWP) could be adjusted by selecting the appropriate angle of the Trendelenburg position.²⁶ The possibility of the Trendelenburg position aggravating the symptoms if gastro-esophageal reflux is present in a parturient, should be borne in mind. In our study, no patient complained of general discomfort, headache or heartburn from gastro-esophageal reflux in the head-down position. Thus, our study further suggests that the Trendelenburg position may be safely used during epidural puncture and catheter insertion for labour analgesia. In a patient known to experience marked symptoms of heartburn in the head-down position, presumably from gastro-esophageal reflux disorder, it would be prudent to avoid the Trendelenburg position and rather use the lateral recumbent horizontal position for epidural catheter placement.

The adoption of the lateral recumbent, 25-head-down position, for the performance of lumbar epidural blockade in labour or at term, may confer a significant benefit, by lowering the incidence of lumbar epidural venous puncture, with its attendant risk of accidental intravascular injection.

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