Insertion length and resistance during advancing of epidural catheter

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Abstract

Purpose. The migration of an epidural catheter into the intravascular and subarachnoid spaces sometimes occurs. This study was designed to investigate where the resistance was felt during the advancing of the catheter into the epidural space and whether the length of catheter advanced in the epidural space affected the incidence of catheter migration.

Methods. One hundred and twenty women, American Society of Anesthesiologists (ASA) 1 or 2, scheduled to undergo lower abdominal surgeries with epidural anesthesia were randomly assigned to two groups according to the length of the epidural catheter advanced; 4 cm (n = 60) or 8 cm (n = 60). The length where resistance to advancing the catheter was perceived was recorded in all patients, and the incidence of aspiration of blood or cerebrospinal fluid (CSF) was obtained. Further, the catheters removed 48 h after surgery were scrutinized for their bending sites.

Results. Resistance was felt in 83 (69.2%) patients and the mean length in the epidural space at which resistance was found was 2.5 ± 1.2 cm. Blood was aspirated in 9 (7.5%) patients when resistance to advancing the catheter was overcome, but CSF was aspirated in no patient. A distal bend was observed 2.4 ± 1.3 cm from the tip of the catheter, and the sites of bending were correlated with the length where resistance was encountered. An additional proximal bend was observed in 35 (58%) patients in the 8-cm group, and in 2 patients (3%) in the 4-cm group (P < 0.001), probably due to coiling of the catheter.

Conclusion. At approximately 2.5 cm in the epidural space, advancing an epidural catheter causes resistance. Further advancing past this point may cause migration of the catheter into the vessels, or the coiling of the catheter.

Key words Regional anesthesia · Epidural · Complications · Intravascular

Introduction

The improper spread of the local anesthetic due to variations in the epidural anatomy [1–3] and suboptimal positioning of the catheter within the epidural space [4,5] are reasons suggested for failure in epidural anesthesia. An optimal length, varying from 2 to 4 cm, has been suggested for epidural catheter insertion, but this length is associated with the risk of catheter dislodgement during fixation to the skin and patient positioning [6–9]. As a result, anesthetists tend to push in an extra length to avoid dislodgement, especially in obese patients [9]. Insertion lengths of 7 and 8 cm were reported to have a higher incidence (8%–8.3%) of intravascular placement than shorter lengths [7, 8], while in another study, the incidence of intravascular location remained the same with a 3-cm insertion length [6].

We speculate that intravascular or subarachnoid placement is likely to occur during the initial process of catheter insertion [10] when the force applied on the outside catheter is sufficient enough to be transmitted to its tip for penetrating the vessel wall. Once the tip confronts an obstruction, it tends to coil beyond that length [11]. Obstruction encountered by the tip is perceived as resistance to insertion by the operator. As a result of the force applied to overcome the resistance, bends are produced in the catheter that can be seen on its removal. A correlation between what is felt and what is observed can assist in gauging the behavior of a catheter when it is inserted at different lengths inside the epidural space. Investigators have used radiological methods to study the behavior of a catheter inside the epidural space, but it is not feasible to use such methods to determine the point of intravascular placement [12]. This study was designed to investigate where the resistance was felt during the advancing of a catheter into the epidural space and whether the length of catheter advanced in the epidural space affected the incidence of catheter migration.
Patients, materials, and methods

This study was conducted at Jawaharlal Institute of Postgraduate Medical Education and Research, Pondicherry, India, between July 2006 and July 2008, after approval was given by the Institutional Research and Ethics Committee. One hundred and twenty women, American Society of Anesthesiologists (ASA) 1 and 2, scheduled to undergo elective lower abdominal gynecological surgeries were recruited for the study after obtaining informed consent for the study and anesthesia/surgery. Patients with a history of myocardial infarction or cerebrovascular insufficiency, height less than 140 cm, bleeding disorders, and evidence of local infection around the lumbar region, and those on anticoagulant therapy were excluded from the study.

The 120 patients were randomly assigned to two groups, according to the length of epidural catheter to be inserted inside the epidural space; assignment was done by a sealed envelope technique by a person not involved in the study. The allocation sequence was generated by computer in blocks of 10. The groups were based on the length of epidural catheter left inside the epidural space: a length of 4 cm (4-cm group; \( n = 60 \)) and a length of 8 cm (8-cm group; \( n = 60 \)).

All patients were premedicated with diazepam 10 mg (tablet) the night before and in the morning of the surgery. In the operating theater, baseline ECG, heart rate (HR), mean arterial pressure (MAP), and percutaneous oxygen saturation (SpO2) were recorded. Lactated Ringer’s solution (1000 ml), prewarmed to 37°C, was infused over 30 min.

Epidural puncture was performed in the left lateral position with the needle bevel oriented cephalad and perpendicular to the skin, under complete aseptic precautions [13]. The epidural space was identified through the midline approach with an 18-gauge Tuohy needle, using a BD Perisafe Epidural Anesthesia Kit (Becton Dickinson Medical Devices, Suzhou, P. R. China) in the L2–L3 intervertebral space by a loss-of-resistance technique using air and confirmed by negative aspiration of blood and cerebrospinal fluid (CSF).

A multiorifice epidural catheter was inserted according to the designated length for the group through the cranially directed tip of the epidural needle. Anesthesiologists experienced in epidural catheter insertion were asked to note whether any resistance to insertion was felt. The resistance was ranked with a four-point score (1, no resistance and smooth insertion; 2, mild initial resistance and subsequent insertion; 3, continuous resistance to insertion requiring force to overcome; 4, resistance not overcome by force requiring needle repositioning). The length at which the resistance was encountered in threading the epidural catheter beyond the hub of the Tuohy needle was noted. A second attempt, made by reinserting the needle in the same space, was carried out in patients with a resistance score of 4; if this was unsuccessful the epidural block was abandoned.

As soon as the resistance was overcome, a gentle aspiration was done at that length to rule out intravascular or subarachnoid placement, and the remaining length of the catheter was then threaded in. If blood or CSF was aspirated, the catheter was removed and reinserted in the same space. If there was no aspirate, a 3-ml test dose of 1.5% lidocaine with 15 μg adrenaline was administered through the catheter. The presence of clinical signs of an intravascular injection were sought for the following 2–3 min by asking the patient whether she felt dizzy, had tinnitus, or had a metallic taste in her mouth. If there were no signs of an intravascular injection, the catheter was then secured firmly on the back using an adhesive plaster. Five minutes after the test dose, if there were also no clinical signs of a subarachnoid injection, as evidenced by the patient’s ability to move her legs and the absence of hypotension, an additional 13 ml of 2% lidocaine with 5 μg·ml−1 of adrenaline was injected through the catheter in patients in both groups. The patient was turned supine and, with the pin-prick method, the maximum height of sensory level achieved at 20 min was noted. Unilateral block, unblocked sacral segments, low level or a patchy block, or the patient complaining of pain despite adequate height of sensory level were regarded as “unsatisfactory block” before surgery. Patients with unsatisfactory block were administered general anesthesia.

In all patients, epidural morphine (4 mg) was given on demand, or when the visual analogue score (VAS) was more than 5 out of a possible value of 10 cm, to provide postoperative analgesia. The epidural catheter was removed after 48 h and subjected to close scrutiny after removal. The retrieved length and kinks or bends, if any, were further assessed. The most distal point at which the catheter was bent (primary bend) was noted. The primary bend was ranked on a three-point score (1, no bend in the catheter; 2, mild noticeable bend; 3, definitive bend). The catheter was further examined for evidence of any secondary bend between the primary bend and the point where it had been secured to the skin (Fig. 1).

The data were collected and analyzed using SPSS (SPSS, Chicago, IL, USA) statistical software, version 15. The sample size was estimated according to the data collected for all the epidural anesthesias performed during a period of 1 year at our institution; the data revealed a 20% incidence of improper epidural catheter placement with a difference of 15% between the groups at an alpha error of 0.05 at a power of 0.8. Improper epidural catheter placement consisted of unsatisfactory block (unilateral, patchy effect, or patient complaining