Withdrawal forces during removal of lumbar extradural catheters

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Summary
After performing successful continuous lumbar extradural conduction block, we investigated the effects of the extradural insertion technique (midline (M) or paramedian (P)) and patient position during extradural catheter removal (flexed lateral (L) or sitting (S)) on the force required to remove extradural catheters. One hundred parturients were allocated randomly to four groups: ML, MS, PL, PS. The results indicated that neither the midline nor paramedian approach affected withdrawal forces. However, more than 2.5 times as much force was required to remove the catheters when patients were in the flexed sitting compared with the lateral position \((P < 0.005)\). For ease of removal of catheters from the lumbar extradural space, we therefore strongly recommend the flexed lateral position. (Br. J. Anaesth. 1994; 73: 833–835)

Key words
Equipment, catheters extradural.

There have been several anecdotal reports on the difficulties encountered during removal of lumbar extradural catheters and the methods of avoidance [1–3]. In the only comparative study to date, Blackshear, Gravenstein and Radson [4] found that the sitting position provided more resistance during removal of the catheters than the lateral position. However, the approach to the extradural space, that is midline or paramedian, was not mentioned, and as the lumbar extradural catheters traverse either ligaments (midline) or muscles (paramedian) before reaching the ligamentum flavum, the approach to the lumbar extradural space may influence the force required to remove such catheters. The aim of this randomized, comparative study was to confirm the above findings and to determine the effects of extradural insertion route on the force required to remove an extradural catheter after completion of extradural block.

Methods and results
This study was performed in 100 consecutive parturients in whom a 16-gauge lumbar extradural catheter had been inserted for labour, Caesarean section or both, using a standardized set (B. Braun Medical Limited, Ref. 08860170). After obtaining informed consent, patients were allocated randomly to one of four groups, depending on the approach to the lumbar extradural space (midline (M) or paramedian (P)) and the position of the patient during catheter removal (flexed lateral (L) or sitting (S)): ML, MS, PL, PS. Exclusion criteria included patients with chronic low backache or previous lumbar spine surgery.

All extradural catheters were inserted via the L2–3, L3–4 or L4–5 intervertebral spaces with patients in the lateral flexed position, using a 16-gauge Tuohy needle and loss of resistance to air or normal saline to identify the extradural space. The extradural catheter with closed-tip and three lateral eyes was threaded to allow 3–5 cm to remain in the extradural space. The catheter was left in situ until after vaginal delivery and episiotomy repair, or after two top-up doses of dilute local anaesthetic and opioid had been given to patients who had undergone Caesarean section. Patients with inadequate conduction block or inadvertent dural puncture were excluded.

The lumbar extradural catheter was removed by a standard technique. The position of the parturients during removal of the catheter was either lateral or sitting (with legs over the edge of the bed), keeping the lumbar spine, hips and knees flexed. The catheter was connected to a portable force gauge using a knot tied at the 20-cm catheter mark, and slow incremental traction was applied in a direction perpendicular to the skin of the back. Peak tension during withdrawal, measured by an Aikoh CPU digital force gauge (Aikoh Engineering Company, Japan) with an accuracy to within 0.49 newtons (N), duration of conduction block, depth of lumbar extradural space and length of catheter left just before withdrawal were noted; the last two measurements were made to the nearest 0.5 cm. After removal, 20 catheters were tested randomly for break strength using the same equipment.

Data were analysed by one-way analysis of variance (including Kruskal–Wallis test) followed by the Scheffé test, using SPSS (SPSS Inc., Chicago, IL, USA). \(P < 0.05\) was considered statistically significant.

All lumbar extradural catheters were removed...
intact with no knots or acute kinks noted. Patient data, length of catheter in the extradural space, depth of extradural space and duration of catheter in situ were comparable between the four groups (table 1). The force required to remove the catheters was considerably greater in the sitting than in the lateral position (P < 0.005, table 1), regardless of the insertion approach. The greatest recorded forces occurred in the MS (10.00 and 10.49 N) and PS (11.47 N) groups. The mean break strength of 20 extradural catheters that were removed was 19.95 N; the lowest recorded break strength was 17.15 N.

**Comment**

Removal of extradural catheters after lumbar extradural conduction block has been generally regarded as uncomplicated, although several anecdotal reports have described the occasional difficult-to-remove catheter, and manoeuvres used to remove them [1–3]. While a flexed back has been generally advocated during catheter removal (with the exception of Ballance [2], who removed a trapped extradural catheter when his patient inadvertently extended the back), neither the patient’s position during catheter removal (lateral or sitting) nor the approach to the lumbar extradural space (midline or paramedian) have been investigated fully.

Blackshear, Gravenstein and Radson [4] found that the force required to remove a lumbar extradural catheter in the sitting position was more than twice that required when patients were in the lateral position. However, the length of the catheter in, and the approach to, the extradural space were not mentioned. The former is important as the greater the length of catheter threaded into the lumbar extradural space, the greater the risk of the catheter curling up, doubling back or forming kinks or knots [3, 5]. The resulting resistance to catheter withdrawal would thus compound that attributed to anatomical structures (lumbar spines [1] or ligamentum flavum [2]) that hinder catheter withdrawal. Browne and Politi [3] suggested that not more than 5 cm should be introduced into the extradural space to prevent such catheter “abnormalities”. The approach to the lumbar extradural space may also be important, not only because with the midline approach there is a greater possibility of the catheter curling up on itself [5], or becoming wedged between two lumbar spines [1], but also because the catheter traverses the tough and dense supra- and interspinous ligaments in the lumbar region. In contrast, during the paramedian approach the catheter traverses the less dense paravertebral muscles. These structures may thus provide different resistances to withdrawal of the extradural catheters.

In the present study we standardized the length of catheter in the extradural space at 3–5 cm although catheter migration resulted in some values beyond this range. We confirmed Blackshear’s report [4] indicating that catheters removed in the sitting position required a force more than 2.5 times greater than that required in the lateral position. Although the margin of safety with respect to catheter breakage during removal is, in general, quite high (3.68 and 3.78 N mean withdrawal force with patients in the sitting position compared with 19.95 N mean catheter break strength), there were occasions when this margin was greatly reduced; the three greatest forces were 10.00, 10.49 and 11.47 N in the sitting position compared with 17.15 N obtained for the lowest catheter break strength. We have also demonstrated that neither the midline nor paramedian approach influenced withdrawal forces of the extradural catheters. There are two possible explanations for this. First, when patients are in the sitting position, similar structural or conformational changes occur in both paravertebral muscles and the supra- and interspinous ligaments, such that catheters are gripped equally firmly (but more so than in the lateral position). Second, it seems likely that most of the resistance encountered during catheter removal in the sitting position with the lumbar spine flexed occurs in the ligamentum flavum because of axial loading of the vertebral interspaces [6], and not in the structures superficial to it.

In summary, the force required to remove lumbar extradural catheters was not affected by the approach to the extradural space, but was significantly greater in the sitting than in the lateral position during withdrawal. The flexed lateral position is thus recommended for extradural catheter removal, especially if undue resistance is encountered during such a procedure when the patient is siting.

**Table 1** Patient data and extradural catheter withdrawal force (mean (SD or range)). Groups ML, MS, PL, PS = insertion technique (midline (M) or paramedian (P)) and position of patient during catheter removal (lateral (L) or sitting (S)). *P < 0.005 MS or PS compared with ML or PL

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<th>Group ML</th>
<th>Group MS</th>
<th>Group PL</th>
<th>Group PS</th>
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<tr>
<td>No. of patients</td>
<td>25</td>
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<tr>
<td>Age (yr)</td>
<td>28.04 (16–35)</td>
<td>27.4 (15–40)</td>
<td>28.16 (19–35)</td>
<td>29.80 (17–40)</td>
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<td>Height (m)</td>
<td>1.64 (0.09)</td>
<td>1.60 (0.07)</td>
<td>1.60 (0.07)</td>
<td>1.60 (0.08)</td>
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<td>Weight (kg)</td>
<td>77.19 (14.84)</td>
<td>71.72 (13.29)</td>
<td>71.67 (10.62)</td>
<td>72.77 (11.65)</td>
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<tr>
<td>Length of catheter in extradural space (cm)</td>
<td>4.04 (0.83)</td>
<td>4.00 (0.83)</td>
<td>3.70 (0.71)</td>
<td>3.96 (0.88)</td>
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<td>Depth of extradural space (cm)</td>
<td>5.18 (0.95)</td>
<td>4.96 (0.72)</td>
<td>4.74 (0.61)</td>
<td>5.10 (0.72)</td>
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<td>Duration of catheter in extradural space (h)</td>
<td>6.92 (2.82)</td>
<td>7.30 (3.63)</td>
<td>6.12 (2.55)</td>
<td>6.20 (2.66)</td>
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<td>Force required to remove extradural catheter (N)</td>
<td>1.57 (0.96)</td>
<td>3.78 (2.80)*</td>
<td>1.27 (0.60)</td>
<td>3.68 (2.33)*</td>
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References


