Anaesthesia, 1997, **52**, pages 457–459

APPARATUS

Evaluation of thoracic epidural catheter position and migration using radio-opaque catheters

G. W. H. Hendriks, M. A. W. M. Hasenbos, M. J. M. Gielen, J. v. Egmond and J. O. Barentsz

Department of Anaesthesia, Academic Hospital Nijmegen, Geert Grooteplein 10, PO Box 9101, 6500 HB Nijmegen, The Netherlands

Summary

Migration of thoracic epidural radio-opaque catheters was evaluated in 25 patients scheduled for thoracic surgery in the supine position ($n = 5$) or in the lateral position with lateral extension of the thoracic spine ($n = 20$). Chest radiography was performed daily for 3 days after operation. Eighty-nine per cent of catheter tips were visualised in the epidural space. The catheter tip position was unchanged in all patients operated upon in the supine position. In the group operated upon in the lateral position, the catheter tip retracted from day 1 to day 2 by an average of 0.69 cm (SD 1.08; $p < 0.05$); from day 2 to day 3 the average retraction was 0.35 cm (SD 0.67; $p < 0.05$).

Keywords *Anaesthetics, regional*; epidural. *Equipment*; catheters.

Correspondence to: G. W. H. Hendriks
Accepted: 30 October 1996

The effectiveness of epidural anaesthesia is influenced by the level of epidural catheter insertion and the catheter tip position [1–3]. It is advisable to insert the catheter proximal to the segments to be treated [2, 4]. Three methods for evaluation of the catheter position in the epidural space have been described. These techniques either require radio-opaque dye [1–3, 5–7] or are indirect [5]. We evaluated the visibility and migration of catheter position at the high thoracic level using a radio-opaque epidural catheter and postoperative chest radiography.

Methods

The study was approved by the hospital medical board according to the declaration of Helsinki and informed patient consent was obtained. Patients scheduled for major thoracic surgery received a high thoracic epidural using a 17 gauge epidural (Tuohy) needle inserted at the T_{3-4} level in the sitting position. The epidural space was located by the paramedian approach using the hanging drop technique. The needle orifice was directed cephalad and a 19 gauge radio-opaque epidural catheter (Arrow International Inc.) was inserted 3–4 cm in a cephalad direction. The catheter was fixed in a loop with Duoderm® (a hydro-active wound dressing: ConvaTec™, UK) and Fixamul® (an adhesive plaster: Beiersdorf AG, Hamburg).

Initially, epidural analgesia was provided by bupivacaine 0.5% (6–8 ml) with adrenaline ($5\ \mu g.ml^{-1}$) and a bolus dose of nicomorphine 5 mg in 5 ml dextrose 5%. General anaesthesia was induced with thiopentone $3–5\ mg.kg^{-1}$ and maintained with halothane or isoflurane in N_2O/O_2. Vecuronium was used for muscle relaxation and all patients were subject to mechanical ventilation. During surgery, the patient was positioned in either the supine or lateral position. The lateral position involved a degree of lateral extension of the thoracic spine to assist surgical access. A continuous epidural infusion of bupivacaine 0.75% at a maximum rate of $2\ ml.h^{-1}$ was started for maintenance of epidural analgesia. If pain relief was judged insufficient, nicomorphine $0.4\ mg.ml^{-1}$ was added.

An antero-posterior chest X-ray was performed daily on each of the first three postoperative days. All radiographs were examined by a radiologist to assess catheter placement and position. Position was recorded as either cranial, at the level of insertion, or caudal and the position on days 2 and 3 was compared to that on day 1.

Statistical analysis was performed using SAS statistical procedures (SAS Inc., South Carolina, USA). Paired

observations were analysed using paired Student's *t*-testing. In all tests a confidence level of $p = 0.05$ was used to define statistical significance.

Results

Twenty-eight patients were studied. In 25 patients (89%) (11 women and 14 men) (14–72 years) the epidural catheter was visualised by a single chest X-ray and these patients were evaluated.

Most catheters were inserted at T_{3-4}, but chest radiography revealed that in four cases the insertion level was one space higher than intended and in one case one space lower. In two cases the level of insertion could not be assessed. Thus, at least 20% of the catheters were not inserted at the intended space.

The first postoperative chest radiograph showed that nine catheter tips were located cephalad and 13 caudal to the point of insertion. This occurred despite having the bevel of the Tuohy needle directed cephalad during insertion. In only one case was the catheter tip identified at the point of insertion.

Twenty patients were operated upon in the lateral position and five patients in the supine position. Migration outwards was found only in the patients who were operated upon in the lateral position. This mostly occurred between days 1 and 2 and between days 2 and 3 (Table 1). No correlation (Pearson test) was found between migration occurring between days 1 and 2 and that between days 2 and 3. It is remarkable that none of the patients operated upon in the supine position showed catheter migration.

Discussion

Postoperative chest radiography revealed the catheter tip in almost all cases. Other investigators have used radio-opaque dye which may cause allergic reactions [5] and possible contamination because of temporary disconnection [1–3, 5–11].

Table 1 Mean catheter migration between the days shown after operation in patients with high thoracic epidurals operated upon in the supine or lateral position.

Retraction	Mean (cm)	p
All patients		
day 1–2 ($n = 25$)	0.56 (1.01)	0.02*
day 2–3 ($n = 25$)	0.29 (0.62)	0.04*
Lateral position		
day 1–2 ($n = 20$)	0.69 (1.08)	0.01*
day 2–3 ($n = 20$)	0.36 (0.67)	0.04*

* $p < 0.05$ between days 1 and 2 or 2 and 3.

Despite the fact that the orifice of the epidural needle was directed cephalad and the catheter was advanced 3–4 cm in the same direction, only 39% of the catheters were in the cephalad position. In a study of lumbar epidural catheters [6] 70% followed a cephalad direction and it was suggested that the procedure should be performed in the posterior median aspect of the lumbar region as this is the widest part and will aid successful positioning. A similar study [7] showed 48% cephalad, 9% caudal and 43% neutrally positioned catheters compared to the insertion level. Another group [3] reported 32% caudal and 68% cephalad directed lumbar epidural catheters and showed that more local anaesthetic is necessary to achieve a given sensory level of block if the catheter moves caudally instead of cephalad. A possible explanation for the small percentage of cephalad directed catheters in our study may be the smaller volume of the thoracic epidural space compared to that of the lumbar space [12].

The combination of Duoderm® and Fixamul®, as used in this study, is a reliable method of securing an epidural catheter [5] and none of our catheters became dislodged accidentally during the study period. In contrast to Mourisse and colleagues [5] we noted the outward migration of the catheter tip. This movement occurred mainly from day 1 to day 2 in the group operated in the lateral position. During this period, patient movement was maximal and may have caused traction on the catheter and its fixation. Despite the fact that patients are awake on days 2 and day 3 there may be less movement than on the day of operation (day 1). This might suggest that lateral flexing of the spine predisposes to catheter tip migration.

Subatmospheric epidural pressure has been suggested as an explanation for the inward movement of the catheter [13]. Although pleural suction (applied in most patients) was suggested as an explanation this has been questioned [5]. Other workers [14] have suggested that the catheter is drawn inwards by the ligamentum flavum during extension of the spine. In a recent study [15] both inward and outward migration of epidural catheters was observed. Surprisingly, subcutaneous tunnelling of the catheter reduced the incidence of inward, but not outward, migration.

This technique, using a radio-opaque catheter and serial chest radiography is a simple, direct, low-risk method of investigating the position of epidural catheters in the days following insertion. Factors contributing to migration remain undefined and require further elaboration.

References

1 Wulf H, Kibbel K, Mercker S, Maier C, Gleim M, Crayen E. Radiologic position control of epidural catheters (epidurography). An instrument of quality assurance for regional analgesia. *Anaesthetist* 1993; **42**: 536–44.

2 Marquort H, Grenzer G, Schroeder U. Routine postoperative epidural analgesia. X-ray control of epidural catheter position and distribution of epidural contrast media. *Anaesthetist* 1993; **42:** 501–8.
3 Tiso RL, Thomas PS, Macadaeg K. Epidural catheter direction and local anesthetic dose. *Regional Anesthesia* 1993; **18:** 308–11.
4 Park WY. Factors influencing distribution of local anesthetics in the epidural space. *Regional Anesthesia* 1988; **13:** 49–57.
5 Mourisse J, Gielen MJ, Hasenbos MA, Heystraten FM. Migration of thoracic epidural catheters. Three methods for evaluation of catheter position in the thoracic epidural space. *Anaesthesia* 1989; **44:** 574–7.
6 Gotou M, Yokoyama K. Location of Perifix Soft epidural catheter investigated by X-ray. *Masui Japanese Journal of Anesthesiology* 1993; **42:** 922–5.
7 Beck H. The effect of the Tuohy needle direction on epidural catheter position: an X-ray study of 175 epidural catheters. *Regional Anesthesie* 1990; **13:** 42–5.
8 Van Gessel EF, Forster A, Gamulin Z. Continuous spinal anesthesia: where do spinal catheters go? *Anesthesia Analgesia* 1993; **76:** 1004–7.
9 Gielen MJ, Slappendel R, Merx JL. Asymmetric onset of sympathetic blockade in epidural anaesthesia shows no relation to epidural catheter position. *Acta Anaesthesiologica Scandinavica* 1991; **35:** 81–4.
10 Sjøgren P, Gefke K, Banning AM, Parslov M, Overgaard Olsen LB. Lumbar epidurography and epidural analgesia in cancer patients. *Pain* 1989; **36:** 305–9.
11 Andoh K, Shima T, Hoshi K, Hashimoto Y. An X-ray study of catheters abnormally placed in the epidural space. *Masui Japanese Journal of Anesthesiology* 1991; **40:** 1598–602.
12 Morisot P. Is the posterior lumbar epidural space partitioned? *Annales Françaises d'Anesthesie et de Reanimation* 1992; **11:** 72–81.
13 Hjortsø N-C, Lund C, Mogensen T, Bigler D, Kehlet H. Epidural morphine improves pain relief and maintains sensory analgesia during continuous epidural bupivacaine after abdominal surgery. *Anesthesia Analgesia* 1986; **65:** 1033–6.
14 Phillips DC, Macdonald R. Epidural catheter migration during labour. *Anaesthesia* 1987; **42:** 661–3.
15 Bougher RJ, Corbett AR, Ramage DTO. The effect of tunnelling on epidural catheter migration. *Anaesthesia* 1996; **51:** 191–4.