Original Article

Epidural catheter migration in non-obstetric adult surgical patients: A prospective, observational, cohort study

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ABSTRACT

Background and Aims: Epidural catheter migration is a well-described complication in the obstetric population, though its significance in the non-obstetric surgical population is not known. The purpose of this study was to explore the incidence of epidural catheter migration in a non-obstetric adult surgical cohort, assess the factors associated with migration and analyse complications among patients with and without catheter migration. **Methods:** In this single-centre, prospective, observational study, the acute pain services team collected data over 12 months on consecutive, adult non-obstetric surgical patients who received an epidural catheter for postoperative pain management. Details of epidural catheter insertion, fixation, migration and complications were collected from the first to the fourth postoperative day. **Results:** Of the 510 patients recruited, epidural catheter migration was noted in 233 patients (45.7%), of which 152 (65.2%) migrated outwards and the rest migrated inwards. Also, 72 (30.9%) and 86 (31.05%) complications were noted in the groups with and without catheter migration, respectively. The most frequent complications noted were inadequate analgesia, unilateral sensory block, motor block and hypotension in both groups. We did not find any correlation between the frequency of epidural catheter migration and demographic factors. **Conclusions:** Epidural catheter migration is a sizeable postoperative occurrence in non-obstetric surgical patients. Factors that might play a role in catheter migration could not be established in this study. There is an almost similar frequency of complications noted among patients with and without catheter migration, with the most common being inadequate analgesia in both groups.

Key words: Analgesia, dressing, epidural, catheter, migration

INTRODUCTION

An epidural anaesthetic, whether used alone or in conjunction with a general anaesthetic, offers several advantages in the perioperative period.[1,2] Apart from incorrect catheter insertion, aberrant anatomy and pharmacological reasons for an epidural block failure, migration of the epidural catheter may play a significant role in parturient receiving a labour epidural.[3-5] Moreover, catheter migration is attributed as a significant cause of epidural analgesia failure in the non-obstetric population also with variable reasons.[6] However, various aetiologies related to catheter migration are not very well reported in non-obstetric adult surgical patients.

The primary objective of this study was to establish the incidence and direction of epidural catheter migration in an adult non-obstetric surgical cohort. Secondary objectives included the assessment of potential risk factors for epidural catheter migration

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and the incidence of adverse events in patients with and without catheter migration.

METHODS

After approval from the institutional review board and ethics committee was obtained (IRB Min. No. 12952 [OBSERVE] dated 24.06.2020), 510 consecutive adult non-obstetric surgical patients were recruited in this observational, prospective, cohort study from September 2020 till September 2021. This study followed the principles of the Declaration of Helsinki, 2013. This manuscript adheres to the applicable strengthening the reporting of observational studies in epidemiology (STROBE) checklist[7] for observational studies.All patients who received an epidural catheter (B. Braun Perifix set manufactured by B. Braun Medical Industries Sdn. Bhd, Penang, Malaysia) as part of their anaesthesia were provided with an information sheet detailing the purpose and method of the study. Written informed consent was taken from the patients for participation in the study and use of the patient data for research and educational purposes, by the acute pain services team of the department of anaesthesiology. Patients aged less than 18 years, parturients, those with spinal deformities and those who did not give consent were excluded from the study. Data on patient characteristics that were collected included age, gender, body mass index (BMI), height, the position of the patient during catheter insertion, site of intervertebral space, midline or paramedian approach, depth of the space, the extent of the catheter that was threaded in the epidural space (in cm), type of dressing used to fix the catheter to the skin, complications noted, such as inadequate analgesia, unilateral sensory or motor block, hypotension, urinary retention and withdrawal or premature removal of the catheter. These data were noted in the structured proforma used in the study.

The magnitude of catheter displacement was determined by comparing the marking on the epidural catheter at the skin on the first, second and third postoperative days during a dressing change, with the marking documented in the intraoperative record by the anaesthesiologist who placed the catheter. We noted three types of dressings that were used to fix the catheter to the patient's skin: Tegaderm with pad (3M™ Tegaderm™ HP + pad film dressing with non-adherent pad 8596, 9 × 10 cm), plain Tegaderm (3M™ Tegaderm™ 8526IN, 10 × 12 cm) and a combination of both.

All patients received 0.1% bupivacaine with 2 μg/mL of fentanyl for postoperative analgesia, with the individual dosing regimen at the discretion of the attending anaesthesiologist. The cold stimulation test for a reduction in cold perception, was used to assess the sensory block in the thoracic, lumbar and sacral dermatomes. This was performed using an ice cube within a rubber glove . Motor block was assessed using the modified Bromage score. 'Inadequate analgesia' was categorised as pain intensity of 4 or more on the 11-point numerical rating scale (NRS) despite the maximum prescribed infusion rate, which usually necessitated the use of additional epidural top-ups by the acute pain services team or the use of systemic pain medications including opioids by the surgical team. 'Premature catheter removal' referred to removal of the epidural catheter within 48 h after insertion, as a result of any complication. Other adverse events documented were hypotension, urinary retention (defined as patient failing trial of voiding within 6 h of urinary catheter removal and with a distended bladder on ultrasound), and catheter manipulations including withdrawal, resiting or removal. The pain score with NRS is a subjective scale and, thereby, is heavily patient and observer dependent. However, as this is being routinely used in the perioperative wards, we used the same in the study.

Based on a previous audit on 208 patients conducted in the Department of Anaesthesiology at our center between August and November 2018, we noted an incidence of 70 (33.65%) catheter migrations. Using the above data, with 80% power to detect an estimated risk difference of 12% between the two groups (patients whose catheters had migrated vs. those with no migration) and a critical level of significance of 5%, a total sample size of 500 participants was calculated. Data was entered using EpiData software (version 3.1) and outliers were screened for. Summary statistics were presented as mean (standard deviation) for description of normally distributed data and median (interquartile range [IQR]) for non-normally distributed data. The Chi-square test was performed for categorical variables with groups (inward and outward migration). A *P* value of less than 0.05 was considered significant. All the statistical analyses were completed using Statistical Package for Social Sciences (SPSS) software for Windows, version 25.0 (International Business Machines Corp., Armonk, NY, USA). There was no missing data or loss to follow-up to be addressed.

RESULTS

Five hundred and ten patients were enroled in the study, all of whom were assessed for evidence of epidural catheter migration till the fourth postoperative day or until removal of the catheter, whichever was earlier [Figure 1]. There were 256 (50.2%) lumbar epidurals; 448 (87.8%) epidural catheter insertions were performed in the sitting position. Most of the epidural space was located at 4–6 cm [Table 1]. There was one patient with a dural puncture wherein the catheter could not be threaded into the subarachnoid space and was successfully resited in the epidural space at a different intervertebral level. There were no patients with subarachnoid or intravascular migration of the epidural catheter.

Epidural catheter migration was noted in 233 (45.7%) patients, of whom 152 (65.2%) had an outward migration of the catheter [Figure 2]. We performed a subanalysis of the following factors to see if there was any correlation with epidural migration: BMI (P = 0.72), vertebral space of epidural insertion (P = 0.62), length of the catheter in epidural space (P = 0.18), tunnelling (P = 0.11) and the type of dressing (P = 0.89) used to fix the catheter on the skin. Based on the above, we found no significant correlation of any of these factors with epidural migration in our study.

This study showed a higher frequency of complications among patients with outward migration of the catheter than with inward migration (47 vs. 25). Inadequate analgesia and unilateral block were frequently noted in patients with both outward and inward migration. There was no difference in the rate of epidural migration among patients who had general anaesthesia (GA) plus epidural or combined spinal epidural.

We compared the frequency of complications noted in patients with and without epidural migration [Table 2]. Seventy-two (30.9%) complications were noted among patients with epidural catheter migration. Also, 86 (31.05%) complications were noted among the 277 patients without epidural catheter migration. The relatively frequent complications noted in both groups included inadequate analgesia (27.9%), motor block (18.6%), unilateral sensory block (15.1%) and hypotension (12.8%).

DISCUSSION

Our study detected a 45.7% incidence of catheter migration among the 510 patients recruited. Differing incidences of epidural catheter migration ranging from 36% to 54% in obstetric patients[5,8,9] and from 6% to 9% in non-obstetric surgical patients[10,11] have been quoted in the literature. Sharma *et al*.[10] reported outward catheter migration at 72 h postoperatively in 12 out of 200 orthopaedic patients who received

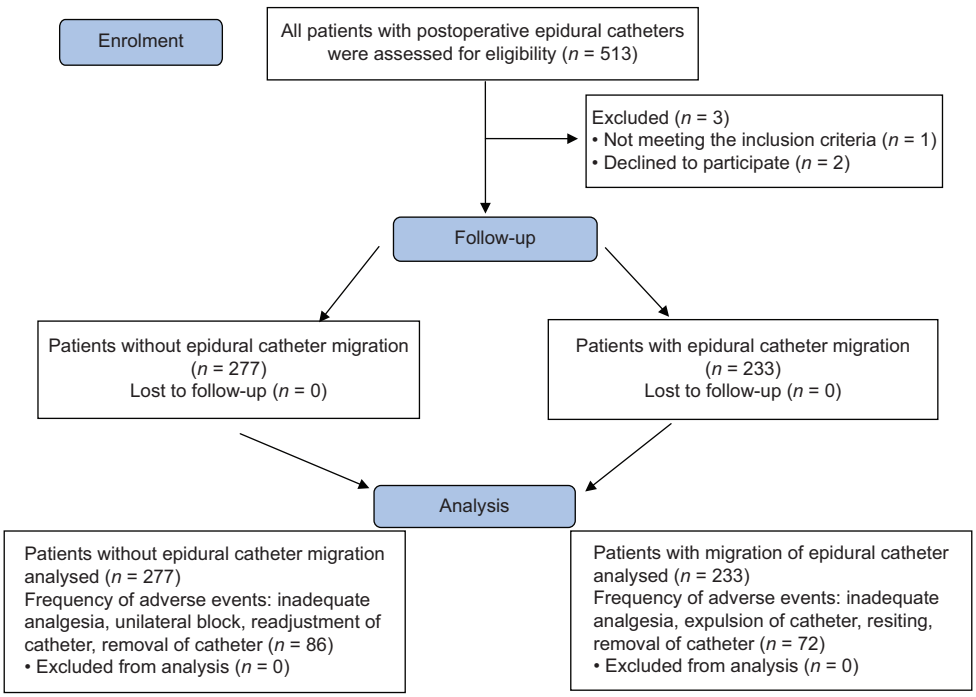

Figure 1: Participant flow diagram

epidural catheters as part of their anaesthesia. Uchino *et al*.[11] used postoperative epidurography to study lateral misplacement of the catheter through the intervertebral foramen in 41 out of 415 non-pregnant surgical patients. These studies on non-obstetric patients have reported a lower incidence of catheter migration compared to our study. The higher incidence of migration in our study may be attributed to the fact that the epidural catheters were left *in situ* for up to four postoperative days as per the practice at our institution. By this time, many of the patients had ambulated, which might have further contributed to the higher incidence of migration noted in our study. A majority of the migrations (41.6%) in our study occurred on the third postoperative day.

Table 1: Demographic data

Variables	Median (IQR)/ Number (%)
Age in years	43 (32–56)
Male	338 (66.3%)
Height (cm)	162 (156–168)
Body mass index (Kg/m^2)	24.2 (21.0–27.0)
Type of surgery:	
Orthopaedics	211 (41.4)
General surgery	224 (43.9)
Urology	56 (11)
Gynaecology	7 (1.4)
Plastic surgery	6 (1.2)
Epidural analgesia without surgery	6 (1.2)
Type of anaesthetic:	
General anaesthesia with epidural analgesia	358 (70.2)
Combined spinal and epidural anaesthesia	146 (28.6)
Epidural analgesia	6 (1.2)
Epidural approach:	
Midline	486 (95.3)
Paramedian	24 (4.7)
Position of the patient:	
Sitting	448 (87.8)
Lateral decubitus	62 (12.2)
Site of intervertebral space:	
Lumbar	256 (50.2)
Lower thoracic	113 (22.2)
Mid-thoracic	141 (27.6)
Depth of epidural space (cm)	5.00 (4.00–6.00)
Length of catheter in epidural space:	
3 cm or less	2 (0.4)
4–6 cm	486 (95.3)
More than 6 cm	22 (4.3)
Duration of epidural catheter:	
3 days or less	305 (59.8)
4–6 days	203 (39.8)
6–8 days	2 (0.39)

IQR=Interquartile range; cm-Centimeter

With respect to factors that affect epidural migration, we did not find any statistical correlation with patient characteristics such as BMI or the level of vertebra where the catheter was inserted, depth of the space or the practice of tunnelling. However, literature is rife with inconsistent correlations between epidural migration and one or more of these factors.[12,13] In obstetric patients, patient's weight, BMI and depth of epidural space were shown to be associated with higher incidence of epidural catheter migration.[5] In contrast, there is also literature evidence to show that the above-mentioned patient characteristics, the intervertebral space or the duration of labour does not affect epidural catheter

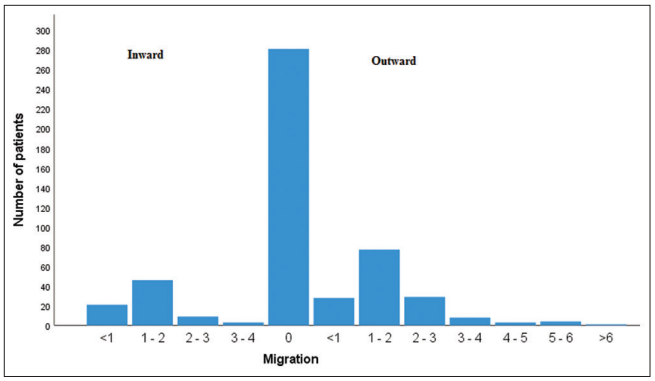

Figure 2: Details of epidural catheter migration seen in the study participants. X-axis denotes the magnitude of catheter migration in centimetres and Y-axis denotes the number of patients

Table 2: Complications in patients with and without epidural migration

Complications	Number of complications in patients without epidural migration (*n*=86)	Number of complications in patients with epidural migration (*n*=72)
Inadequate analgesia	24	21
Motor block	16	12
Unilateral sensory block	13	13
Hypotension	11	10
Premature removal	10	8
Accidental complete extrusion of catheter	7	2
Catheter adjustment required	2	4
Urinary retention	1	2
High sensory block (above T4)	1	0
Pruritus	1	0

Data represented as numbers

migration rates in parturients.[8,14,15] In non-obstetric population, patient characteristics have not been shown to be associated with epidural catheter migration except for the methods of catheter fixation.

A variety of catheter fixation techniques have been studied with respect to their efficacy in preventing catheter migration. Our study showed no significant relationship between the type of dressing used and the rates of catheter migration (45.3%- Tegaderm with pad, 44.5%- plain Tegaderm, 45%- combination of the above two dressings). In 200 orthopaedic patients, Sharma *et al*.[10] studied subcutaneous tunnelling versus Lockit epidural catheter clamp and noted 12 cases of outward migration in the tunnelling group and none in the Lockit clamp group. Chadwick *et al*.[16] compared tunnelling of the epidural catheter with a technique of using a strip of adhesive foam folded around the catheter exit site in patients undergoing major abdominal surgeries and observed no difference in the epidural catheter migration rates between the two groups. Whatever the technique of catheter fixation may be, firmly adhering the catheter at the skin exit site does not always prevent coiling of the catheter beneath the skin.[17] This brings to light the problem of analgesic failure due to subcutaneous looping of the catheter, which may be curtailed by leaving a sufficient length of catheter within the epidural space[18] or by allowing the patient to relax (from flexion) and return to neutral position before fixing the catheter at the skin.[19]

Our study showed almost twice the occurrence of complications in patients with outward catheter migration compared to those with inward catheter migration, with inadequate analgesia being the most frequent adverse event in both groups. We found no correlation between the distance of catheter migration and the frequency of complications. Also, in addition to the magnitude of catheter migration, the direction of migration (outwards or inwards) did not correlate with a unilateral block or failed block.

We compared the frequency and types of complications among patients with and without epidural catheter migration [Table 2], wherein we noted an almost similar pattern of complications except for a higher incidence of accidental catheter extrusion in the group without catheter migration. Thus, it may be that catheter migration may not be the principal contributory factor towards the occurrence of complications, especially inadequate analgesia, which was the most common complication noted. This is comparable to the studies done by Burstal *et al*.[20] and Chadwick *et al*.,[16] where the authors have demonstrated that there was no association between catheter migration and inadequate pain relief. Some authors have suggested that inadequate analgesia may be associated with a greater length of catheter within the epidural space,[21,22] as this allows the catheter to get displaced or migrate into the anterolateral aspect of the epidural space. Additionally, it may be that subcutaneous looping or dislodgement of the catheter without visible migration outside the skin might be present in patients who have had adverse events in the group without catheter migration.[23]

We did not note any migration of the epidural catheter into the intravascular compartment or subarachnoid space in our study.

Apart from the major limitation of biases attendant on the observational study design, our study was not powered to study the correlation between various factors that might affect epidural catheter migration, such as patient weight, BMI, vertebral space of catheter insertion, tunnelling or dressing used to fix the catheter. We have not compared the experience level of the provider with the rate of catheter migration, which might have an impact on catheter migration. While we have tabulated the complications noted in the groups with and without catheter migration, our study has not analysed the reasons for specific adverse events such as inadequate analgesia, motor or sensory block, or premature catheter removal in either group.

CONCLUSION

The incidence of epidural catheter migration is 45.7% in the non-obstetric patients undergoing surgery. The frequency and profile of complications are similar in patients with catheter migration and without catheter migration.

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No external funding was sought as the data was collected from the Anaesthesia Record and Acute Pain Services Record of the patients recruited.

Conflicts of interest

There are no conflicts of interest.

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